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INDUSTRIAL QUALITY CONTROL

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HAROLD S. BLACK, LAMME MEDALIST

A MAN WINS A MEDAL...AND STRENGTHENS A PHILOSOPHY

The search for the "hitherto unattainable" sometimes ends in strange places.

For years Bell Laboratories engineer Harold S. Black pondered a problem: how to rid amplifiers of the distortion which unhappily accumulated as signal-transmission paths were made longer and amplifiers were added. There had been many approaches but all had failed to provide a practical answer.

Then one day in 1927 the answer came—not in a research laboratory, but as he traveled to work on the Lackawanna Ferry. On a newspaper, Mr. Black jotted down those first exciting calculations.

Years later, his *negative feedback principle* had revolutionized the art of signal amplification. It is a principal reason why telephone and TV networks can now blanket the country, the transoceanic cable is a reality, and military radar and missile-control systems are models of precision.

For this pioneer achievement, and for numerous other contributions to communications since then (some 60 U. S. patents are already credited to him), Mr. Black received the 1957 Lamme Medal from the American Institute of Electrical Engineers. He demonstrated that the seemingly "unattainable" often *can* be achieved, and thus strengthened a philosophy that is shared by all true researchers.

He is one of many Bell Telephone Laboratories scientists and engineers who have felt the challenge of telephony and have risen to it, ranging deeply into science and technology. Numerous medals and awards have thus been won. Two of these have been Nobel Prizes, a distinction without equal in any other industrial concern.

Much remains to be done. To create the communication systems of the future, we must probe deeper still for new knowledge of Nature's laws. We must continue to develop new techniques in switching, transmission and instrumentation for every kind of information-bearing signal. As never before, communications offer an inspiring challenge to creative men.

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INDUSTRIAL QUALITY CONTROL

Vol. XVII, No. 1 July, 1960

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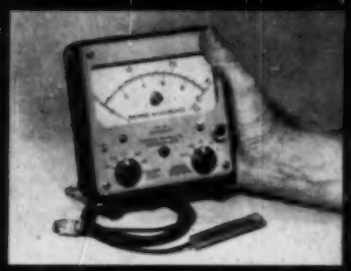

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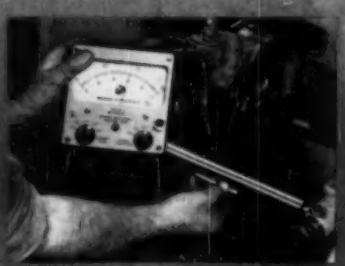

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CONTROL

The Role of Quality Assurance In Product Reliability

Part I

E. G. D. PATERSON

Bell Telephone Laboratories, New York, N.Y.

SINCE it is the purpose of this article to outline the more important ways in which a comprehensive quality assurance program contributes to reliability, it is desirable to reach an early understanding as to the meaning of the two terms as used herein. Unfortunately, the operational boundaries of neither the Quality Assurance nor Reliability programs have been specifically defined;[1] in practice they vary widely from one industry to another. We have, for example, a reliability group as part of a military design function in Bell Telephone Laboratories and an independent Quality Assurance Department which concerns itself primarily with Bell System communication product. This is not to imply that the reliability group has no interest in the overall quality of military product nor that Quality Assurance overlooks reliability as a necessary constituent of good communication equipment. Good quality without reliability is obviously an absurdity; and reliable product is quite likely to be of good overall quality.

Quality Assurance is a term coined by Bell Telephone Laboratories many years ago. As practiced in the Bell System and as referred to herein, its purpose and historical background have already been described.[2] Suffice it to say at this point that it represents a broad-gauge program, inaugurated almost forty years ago, in which attention to quality starts with design and proceeds through production and use; in which standards for quality are established in terms of satisfactoriness, adequacy, dependability and economy (the SADE Q of W. A. Shewhart)[3]; and in which quality measurements and evaluations are used for the purpose of correction as well as protection. Concern about reliability (dependability) was thus a specifically recognized attribute of quality assurance from the outset.

In the extensive literature on the subject, reliability is generally related specifically to the functioning of the product (sometimes including other factors such as maintainability, availability and "down time"). Unlike quality assurance, reliability does not concern itself with such quality aspects as appearance, efficiency, noise, etc. Unlike quality assurance also, standards of reliability, *per se*, do not ordinarily reflect cost factors, although these latter may, in large degree, influence reliability goals and the success with which they may be attained.

Reliability, of course, represents no new concept to the industrial world. Timepieces, for example, have long been made with high reliability, although their precision (and complexity) is incomparable with that of today's crystal oscillator and atomic clocks. The food freezer in my home has operated continuously without failure, and without any maintenance (discounting frost removal from the freezing compartment) since the first day it was installed some ten years ago.

It is only in recent years that reliability has been singled out for such individual concern as to justify a specialized branch of engineering for its implementation and special technical symposia to assist in its promotion. This status quo resulted largely from our inability to satisfy — reliably — military demands which called for new and complex devices and systems. Limitations as to size and weight allowed much less freedom for the use of that erstwhile shelter for our technological ignorance — the factor of safety — and a much greater premium was placed on its close electronic cousins known as margin and redundancy.

Emphasis on the several aspects of reliability varies with the nature and purpose of the system under consideration. In the communication business, for instance, we are interested in continuous, satisfactory performance over a long period of time involving many individual cycles of operation. We employ few "one shot" devices. Since we are a

Editorial Note

This paper was presented by invitation on the program of the Symposium on Reliability of Service Equipment sponsored by the British Ministry of Supply in London, England, March 22-24, 1960. In releasing this paper for publication in IQC, Mr. Coppock of the Ministry of Supply makes these interesting comments: "We do not necessarily support a separate organization for quality assurance, such as Mr. Paterson describes, though we are interested in its possibilities in many directions. There will in fact be quite a debate on this very point during the Symposium."

The "Comments on the Paper" represent a supplement to it which Mr. Paterson was invited to prepare and present, the paper itself having been distributed for study prior to the actual Symposium dates.

ASQC LCS Codes 300;800:60;70:400

Part II will be published in the August issue, *Industrial Quality Control*.

business enterprise where economy is important, and since we have relatively large elbow-room equipment-wise, if need be we can usually resort to margin, redundancy, and automatic self-checking features to secure the necessary degree of reliability at minimum cost. Such a major decision as one involving a change in our central offices from electro-mechanical to electronic is not dictated by limitations on space or weight but rather by considerations of economy and service. Could we not improve one of the latter — or, as we expect in this instance, both — we would not make the change. Within reason, we can take the necessary time to prove in the reliability of a major innovation.

On the other hand, with respect to many military devices — radars, missiles, air-borne computers, and the like — considerations of national security largely over-ride economic restrictions, and the time element is particularly pressing. Limitations on size and weight may be so controlling as to determine whether a device is or is not feasible. Complexity, the *bete noire* of reliability, confronts us in both the communication and military areas; but to support us in the design and manufacture of reliable commercial communication devices, we could draw on — at least until recently — a relatively much greater store of that priceless ingredient — experience — the true godfather of reliability.

The Hazards of Prediction

Ultimate performance reliability traces its ancestry to the potential reliability incorporated in the design itself. The design establishes an upper boundary which represents a conceivable, theoretical maximum for the actual reliability of the product. It promises, in effect, that if the materials and parts are selected, processed, assembled, and tested ideally as intended, and if the resulting product is operated strictly in the manner and under the environment for which it is designed, then it will have a calculable reliability which would, in fact, be the theoretical maximum. At the design stage there is, of course, no physical product, so that reliability at this point is merely conceptual. Nevertheless, it is this conceptual reliability, a hope of the design intent, which is all too frequently represented as the actual reliability of the finished product.

Long experience in matters of quality and reliability leads me to be uncertain — indeed skeptical — about our ability to predict with confidence the reliability of a new complex device or system with which we have not had a substantial history of actual operating experience. It is one thing to predict the reliability of a new production of, say, automobiles when we have had substantial operating experience* with predecessors of the same basic design produced under closely comparable circumstances. It is quite a different task to predict the reliability of a new and hitherto essentially untried design of missile or satellite. Failures of the Western world in this latter respect are a matter of public record. We do not know what preceded the successes of the Russians. My skepticism about our ability to predict does not arise from questions concerning the mathematics involved in deriving the numerous reliability prediction formulas. It relates, rather, to the pertinence or completeness or applicability of the assumptions underlying the formulas themselves, and more especially to the availability of information which will furnish meaningful empirical values for the constants which reliability prediction formulas necessarily include. Let me elaborate.

A commonly employed assumption says that the average rate of so-called "random" failures is constant, regardless of the particular interval of time in the product's life at which the rate is measured. This assumption enables us to test a large sample for a short time, obtain a failure rate, and apply this failure rate over a much longer period of time. Thus we presume to acquire the necessary empirical information in a time which is appreciably shorter than the expected service life of the product after its manufacture. A serious question arises as to the propriety of the use of a random failure rate so obtained, in the face of the possible onset of such reliability enemies as whisker growth,[4] fatigue, loose connections, intermittent open and short circuits, and other similarly insideous phenomena, some of which are perhaps as yet unknown but almost sure to appear as we employ new technologies and materials. To call these failures "non-random" may remove the onus from the random failure rate prediction formulas, but the true reliability of the product derives no benefit thereby. How realistic also are those formulas which rely upon the assumption that the quality of components, assembly, and workmanship, and the stresses of actual service are the same for the forthcoming production as are those characterized by the formulas. I emphasize the term "assumption" because rarely do the design specifications themselves include the rigorous and comprehensive requirements necessary to insure for the actual production units the equivalent quality characteristics attributed to them in the formulas.

A citation and discussion of the probable merits of the two statements to follow will indicate some of the reason for skepticism and the need for critical evaluation of reliability predictions. Both statements are of recent origin; both relate to subjects pertinent to current reliability problems; and together they span essentially the complete scale of plausibility.

I. In response to a question during a lecture[5] describing to a technical audience the TASI system (Time Assignment Speech Interpolation), the speaker stated that the expected reliability of the transistors in the TASI terminal was such as to cause major failures not more than once in two or three weeks. (Provisions are made for quick detection and correction of such failures). The TASI system is an arrangement which takes advantage of the silent intervals in normal speech. Its use enables the effective channel capacity of the present British-American transatlantic voice-cable to be more than doubled. It employs, among other components, some 16,000 transistors — a fact which prompted the question as to its reliability. It is of particular current interest, since the British terminal is scheduled for installation at about the time of this Symposium. The speaker explained the bases of his forecast as follows:

(1) About half, or 8000, of the transistors are in applications affecting only individual channels. The critical applications (common control circuits), responsible for major failure, use the remaining 8000.

*By substantial experience I mean an aggregate of a *substantial* number of hours of intermittent operation over a two or three-year period for each of a *substantial* number of cars, rather than the equivalent number of operating hours obtained by operating each of a much larger number of cars for a short time.

(2) The transistors to be used are an established "work-horse" design operating well within the margins of their various characteristics.

(3) Experience with their use in comparable applications over a period of several years has shown a failure rate of less than 1 percent per year.*

(4) The transistors are produced by the same factory, using similar materials, processes, and quality control as characterized the transistors which provided the one percent failure rate.

(5) While the TASI equipment is constantly energized and available, its actual service time, its load-factor, is only one-third, since TASI is employed only when traffic demands more than the original cable channel complement.

(6) Transistor failures which occur during the TASI unused interval are detected and removed.

II. In an advertisement in a prominent technical magazine appears the following:

"Use the solderless wrapping method — proved superior by over a billion† connections without a reject . . . mechanically strong connections electrically stable—proved most reliable in industry".

With reference to this latter statement, it should be noted that the Bell System invented the solderless wrapping process, developed it for practical applications, and has undoubtedly had more experience with it — with respect both to time and quantity — than all the rest of industry put together. Western Electric Company's current production of these connections runs in the order of 25 million monthly. I would thus be the last to belittle the excellence of the properly made solderless wrapped connection. But having been personally associated with procedures for assuring control of its quality and reliability from the outset, and having seen data representing actual tests on hundreds of thousands of these connections, I would be the last to endorse the extravagant claim of the quoted statement.

The soldered connection has a reliability demonstrated by well over half a century of actual service. Its use has been and continues to be numbered in the billions. It was not a lack of reliability of the soldered connection which led to the development and use of the new, solderless wrapped connection. Rather it was an urge to save connecting costs, to provide a connection which could be more easily removed or added to, and to furnish a means of connection in wiring fields where lack of space precluded soldering. The integrity of the solderless wrapped connection depends upon an initial hoop stress, and a rate of relaxation under service conditions which is sufficiently low, to insure adequate compression (or possibly a "cold weld") between the encircling wire and its terminal. No significant number of these connections has been in service for a period of more than ten years. Its proved reliability in terms of life expectancy cannot thus possibly be more than some 25 percent of that of the soldered connection.

A claim of a billion connections without a reject represents merely an admission either of ignorance or negligence. Unlike the soldered connection, where visual and prodding techniques suffice, actual measured pull-testing of the solderless wrapped connection is the only known means of determining its initial integrity. With all its experience, with all the controls that represent the best combined efforts of Bell Telephone Laboratories and Western Electric — controls on the wire, the terminals, the wrapping tool, and the operator, and controls that include the actual pull-testing of a sample of over 100,000 connections per month — Western Electric's current process average shows about one failure in 20,000. This is just about the same as the rate for soldered connections. It is a rate incidentially which, in terms of the rigorous criteria by which a good connection is characterized, represents an enviable level of good process quality. But it is a long way from zero in a billion. (Note that at the rate of 100,000 tests a month, it requires over 800 years to accumulate a billion tests. Considering the current rate of technical progress, one might suspect that connecting techniques will have changed somewhat in the interval.)

Now I think that we can agree that the first statement represents a conservative forecast supported by reasoning which is both pertinent and plausible. It represents, with respect to one component only of a whole system, a reliability prediction in which one is inclined to place a high degree of confidence. The second statement — admittedly typical of the loose talk characteristic of much advertising — has, for the purposes of reliability prediction, the technical value of an *ignis fatuus*. It would indeed be fortunate if the relative cogency of all reliability prognostications could be so readily earmarked as the two extremes cited. To illustrate the difficulty which besets us when we move from an individual component or process to the complex realm of the system, consider the dilemma posed by the following instance.

> A fairly complex design of apparatus combining electronic, electro-mechanical, and mechanical features in a compact package was placed into production. The device involved essentially no basically new technology, although the particular combination itself was novel. Service demands precluded preliminary, comprehensive field trial. Each unit was tested and met its performance requirements before it was accepted for service. Early service reports indicated failure rates in excess of those anticipated or desirable. The causes of failure were diverse in nature.
>
> An investigation was inaugurated in the form of a special field trial. Ten units per week were introduced into service in four different geographical locations in the United States, where environment, installation practices, and customer usage might be expected to vary. Only units which had successfully passed at least one, and in some cases two or three, complete inspections without any failures were used. In addition, each unit was given a short pre-service inspection, the point being that only those units which were known to be in a satisfactory operating condition, insofar as inspection could insure this, were placed into service. Detailed records were kept concerning

*This is a value based upon a few years' experience. The reader should neither be apprehensive over its magnitude nor construe it as equivalent to a 100 year mean-life prediction. Transistors have not been in use long enough to support such a forecast. The figure cited has been rounded upward, and there is available data to suggest a lower value. In fact, one of the terminal assemblies employing 8000 of these transistors has been operating for six weeks without any transistor failure. The speaker is a conservative realist not prone to wishful thinking or hazardous promises. His approach does nothing to undermine the reader's confidence nor to make the quality assurance man uncomfortable.

†In America, a billion is 10^9.

pertinent data. The cause of each service failure was isolated and identified. Where field repairs could be made, such was done and the unit was replaced in service. At the end of the trial some 600 units had been introduced into service for periods varying from one to sixty weeks. About 40 separate types of trouble were catalogued. One predominant trouble accounted for about one-third of all service failures. Only a few of the failures were electronic; e.g. tube failures, transformer burnouts, and the like. Most of the troubles were mechanical in nature — adjustments, excess friction, defective switches, deformed parts, dirty contacts, etc.

As was the case in this instance, one does not usually have, in the early stages of design or production, the information which will enable him to forecast the failure rates associated with a unique and particular assembly of components. But should one question the hazards involved in reliability prediction, the following analysis of a representative sample of the failure rate data should be convincing. By no stretch of the imagination could the results obtained by the post mortem process have been even approximately forecast.

Failure Rates (per x* units per week)	Length of Accumulated Service (weeks)
13.7	1
6.8	4
4.0	20
3.5	30
3.2	60

Note that the data showed the failure rate over an extended period to be largely a function of service life, and that several months' operation was necessary to provide a rate which had a semblance of constancy. Note particularly that this history relates to a device employing combinations of known technology, designed by experts working in familiar territory, produced by competent people employing good facilities, and maintained by similarly competent repairmen.

What are the effects, and how do we calculate them, *a priori*, of the more usual circumstances where such a close degree of correlation between designer, maker, and user is lacking, and where the nature of the device leads us into far less explored areas of design, production, and use? To this question, I submit, there is no sound quantitative answer.

Now I do not wish to imply that the competent practitioners in the field of reliability prediction are unaware of the limitations and hazards which I have enumerated.[6] They are diligently endeavoring to eliminate these shortcomings. But, as a quality assurance man, I am particularly concerned about the false impressions which may arise from the misapplication of some of the published prediction figures and formulas. Quality assurance considers this whole problem of quality and reliability from the customers' viewpoint. A customer expects the quality of product which he buys to be at least consistent with the quality spelled out in the specification. He usually expects more. He expects that the product will have a reliability commensurate with the use for which it is designed, even though the word "reliability" may not even appear in the specifications. When the quality assurance man encounters a specification for a new, complex product, in which there is cited an actual value promising a high degree of reliability, associated with an implied high degree of confidence, he is placed in an awkward position. This is because he is a realist and hates to see a false sense of assurance encouraged by what he knows to be gross uncertainty.

*x is a fixed number in disguise.

The Role of Quality Assurance

Despite the aura of innovation which appears to surround the subject, concern for reliability and efforts to achieve it are as old as industry itself. Its necessary antecedents, like those of any other product quality, may be stated simply in general terms as follows:

(1) A conceptual device (or system) which will fulfill the intended function.

(2) A clear, unequivocal, complete statement of requirements coveripg all the parameters of the device necessary to insure its functioning in the manner desired.

(3) Production of the device in strict conformance with these requirements.

The only restrictions imposed upon (1) and (2) are that they involve physical hardware and components which are actually known to be available or producible. Cost may affect the reliability goals which are set, but it is not a factor in reliability *per se*.

Responsibility for the first two antecedents is a function of research and design; responsibility for the third is a function of production. Wherever the first two requisites — a suitable concept, and completely stipulated instrumentation — have been fulfilled, all of the information needed to secure reliability is available. If the actual product meets the stated requirements — all the stated requirements — reliability becomes, without more ado, an intrinsic part of the product. For the more simple and well known designs all three steps are, of course, more easily effected and, because margins are usually an automatic part of the design, shortcomings in step 2 do not have such a critical effect on reliability. In such cases, attention to reliability, and quality in general, has traditionally been directed predominantly to step 3 — production. With new, complex, and unfamiliar designs, all three steps become more difficult; but it is step 2, the specification process, whose difficulties — and resulting inadequacies — are responsible for the major portion of the reliability problem. A reading of the copious literature concerning reliability should resolve any doubts one may have in this respect. So quality assurance, which concerns itself with reliability as well as with other attributes of overall quality, cannot confine its attention to production. This was recognized at the outset; a critical review of the design requirements has always been an important part of the quality assurance process.

With this background, we are ready to discuss in some detail the particular phases of the quality assurance program which appear to provide the most important contribution to the assurance of good reliability. There are three: inspection; the evaluation of, and suitable action in respect to, the results of field performance; and quality survey. Since these, as well as all other phases of quality assurance, are

closely interrelated, the order in which they are listed and discussed has no particular significance. The first, inspection, relates to the control of quality in production, that is, to means for assuring that the quality of the finished product is as specified. I emphasize the work specified because it is the producer's responsibility to meet only those requirements which are specified. (He must, of course, also comply with implied requirements of good workmanship, a somewhat nebulous term characterized by the particular trade involved. If there are pertinent features of workmanship involved which cannot be assumed to be recognized and accepted automatically, then these must also be specified.)

Inspection

The literature on the control of quality in production is extensive; in fact, most of the literature which appears under the subject of quality control has been directed toward this purpose. In the Bell Telephone Laboratories at least, quality assurance is regarded essentially as a customer function, whereas quality control (in its narrower connotation) is a responsibility of the producer. Hence, quality assurance's interest is directed more specifically toward an evaluation of the effectiveness of the control procedures in actual use, since the effectiveness of control determines the degree to which product meets requirements, and the dependability of the inspection results which are used to measure, in part, this degree. Quality assurance must thus be familiar with process control procedures and must, indeed, on occasion insist upon their use as the only means of insuring product quality. On the other hand, inspection represents the direct approach to ascertainment of product conformance. Hence, insofar as quality assurance relies upon inspection results, inspection becomes a responsibility of quality assurance.

For the purpose of clarity, I should like to divide the whole inspection process into two categories:

(1) Inspection which is carried on as a part of the manufacturing process and which, for the sake of simplicity, I will label "shop inspection." This includes raw material, parts, process, and "end" inspection. It serves the triple purpose of protecting the manufacturer's own interests, aiding the smooth flow of production, and supplying, for his own needs, evidence that he has met his responsibility as a reputable manufacturer to produce good quality. The extent and value of this particular inspection process vary from one industry to another. In the Western Electric Company, the manufacturing component of the Bell System, it is comprehensive, thorough, effective, and convincing.

(2) Inspection which is carried on for the purposes of quality assurance. This is a verification inspection, is independent of the shop inspection, and is conducted by the customer or his agent. Its nature and extent vary with circumstances; especially with the character and dependability of the preceding shop inspection. Where insufficient knowledge is available or obtainable regarding the adequacy of the shop inspection, then the quality assurance inspection becomes essentially a lot-by-lot acceptance inspection, sufficient unto itself. Where, on the other hand, assurance as to the adequacy of the shop inspection is available, then the quality assurance inspection becomes, in effect, a procedure for verifying, and securing evidence of, the fact that the previously demonstrated effectiveness of the manufacturer's control of quality continues.

Although quality assurance must insure that both the character and extent of the quality assurance inspection process are adequate, it need not itself carry out any of the manipulative inspection. Actually, Bell Laboratories Quality Assurance performs no routine inspection at all! It uses as its agent for this purpose an independent organization in the Western Electric Company, whose function is to assure Western's own management that its responsibility as a supplier of quality product is effectively exercised. This organization audits product quality. More bluntly stated, it has the effect of "policing the policemen." Procedures, to be described later, are in effect whereby Laboratories' continuing confidence in the propriety of this arrangement is vindicated. The economic advantages of the elimination of Laboratories' inspection, without loss of assurance, thus made possible are obvious.

Laboratories' Quality Assurance specifies how much and when such inspection is to be performed, as well as the acceptance criteria, compliance with which represents in part continuing evidence of product conformance. The nature and extent of inspection necessary depend both upon the degree of assurance of conformance desired, and upon how much of that assurance is supplied by information available from sources other than inspection results upon the product immediately at hand. Two extreme examples will illustrate.

(1) Each electron tube installed in the repeaters employed in the first transatlantic voice-cable was rack-tested for a period of several thousand failure-free hours before it was accepted.

(2) Conformance to several of the requirements controlling the life of telephone drop wire is based upon control criteria* which apply to samples representing approximately one part in 20 million of the output. Field results have shown this inspection technique to be more effective in controlling quality than the one it replaced, in which over a hundred times as large a sample was involved.

The concomitants of a suitable inspection technique vary widely with circumstances. It would be impossible to do more in this limited presentation than to emphasize the importance of designing each inspection program so as to be most effective for the particular design, and the particular production program employed in its manufacture. It is in tailoring the inspection procedures best to fit the particular circumstances, in setting the acceptance criteria (which have a direct relation to expected reliability), and in analyzing and evaluating the significance of the inspection results that quality assurance aids reliability in this phase of its activities.

*As an illustration of the community of interest and the similarity in the basic training and aptitudes involved in the areas of quality assurance and reliability, it is worthy of note that the quality assurance engineer who developed this particular control program is now a reliability engineer supervisor with our military design people.

An Extended

CHAIN SAMPLING

Inspection Plan

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WHEN performing costly or destructive physical or chemical testing by attributes—where each sample unit is considered to be good or bad—the common procedure is to utilize a small sample size and an acceptance number of zero for making acceptance-rejection decisions. The small sample size is dictated by the cost of the test, and the zero acceptance number arises from the desire to maintain a steep OC curve. However, this very steepness, which gives protection against poor quality material, also discriminates against desirable material.

Dodge[1] treats this problem by a procedure called Chain Sampling Plan ChSP-1, which utilizes information on material other than that under test to assist in making the acceptance-rejection decision.

This paper will give a generalization to ChSP-1 in that rejection numbers greater than "1" will be included. This procedure is called Chain Sampling Plan ChSP-4. We note that Reference (2) is a special application of ChSP-4. As with ChSP-1, this proposed procedure can be used to increase the probability of accepting lots which have a desirable or acceptable quality level without materially increasing the probability of accepting material which is excessively defective.

The procedure to be shown here was developed for a special problem on 100 percent testing of torpedoes. For this particular application, the assumption made was that a continuous process, generating an infinite number of units, was in operation. The high cost of the end item plus other considerations dictated 100 percent inspection. This sampling procedure was devised so that the testing agency and the producer would know when this production process and/or the test equipment was out of control. The notion of using a combined series of lots for making acceptance decisions on a single lot evolved from conversations between W. R. Pabst, Jr.*, H. M. Rosenblatt †, and the author during the summer of 1953. The model was formalized and presented in an unpublished memo of Sept. 15, 1953. Reference (2) is a presentation of general sampling plans and OC curves for particular application to torpedoes, and it is based on the 1953 preliminaries.

Application of ChSP-4

Let us consider a situation where we have a continuous supply of material, the testing is destructive in nature, and the sampling plan for the appropriate AQL permits a certain number of defectives for a specified sample size. However, since the Operating Characteristic Curve for this sampling plan reveals that lots with poor quality will be accepted too frequently, the natural step is to reduce the acceptance number.

This procedure results in a smaller probability of accepting poor lots (highly desirable!) and a smaller probability of accepting good lots (undesirable!). Thus, some procedure is needed which will permit

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high acceptance of good material and low acceptance of poor material without increasing the sample size.

If some procedure is used which bases acceptance of one particular lot on the test results of that lot plus other nearby lots, we manage to achieve this desirable state. However, there are certain conditions, essentially the same as those in Reference (1), which must be satisfied before we can get the desirable features of a Chain Sampling Plan.

Conditions

1. The product to be inspected or tested comprises a series of successive lots or batches (of material or of individual units) produced by an essentially continuing process.
2. Under normal conditions, the lots are expected to be of essentially the same quality.
3. The lots are statistically independent of each other, and the sample size is small enough, in comparison with the lot size, to permit the computing of probabilities by use of the Binomial Distribution.

Procedure

1. For each lot, select a sample of n units and test each unit for conformance to the specified requirements.

2. Accept the lot if c (the observed number of defectives) is less than or equal to a (the acceptance number). We call this the First Stage.

3. If c is greater than a for any lot, either one of the following two procedures, which we call the Second Stage, can be followed:

   i. Accept the lot if c′ (the total number of defectives arising from the lot under investigation plus the previous (k—1) lots) is less than or equal to a′ (the acceptance number for the k lots combined). Reject the lot if c′ is greater than a′.

   or

   ii. Defer action until an additional (k—1) lots have been tested. Accept the lot under consideration if c′ (the total number of defectives for the k lots) is less than or equal to a′ (the acceptance number for the k lots combined). Reject the lot if c′ is greater than a′.

4. The number of consecutive lots k must be predetermined as must n, a, and a′. Given these specifications, OC curves can be developed. In addition, for administrative purposes, we must fix whether the (k—1) consecutive lots will be those (k—1) lots just prior to the lot under test or just after it. Please note that (k—1) in this article and in (2) corresponds to i in (1).

5. Steeper OC curves can be obtained by introducing r (a rejection number) on defectives in the sample being tested. For purposes of differentiation we call this plan ChSP-4A. Everything given for ChSP-4 holds for ChSP-4A except that, in the First Stage, rejection of the lot is mandatory if $c \geq r$. Note that $r > a$.

The OC curve for ChSP-4 can be written as:

$$Pa = Pr\,[c \leq a \mid n, p] + Pr\,[c' \leq a' \mid a < c < a', kn, p]$$

The OC curve for ChSP-4A can be written as:

$$Pa = Pr\,[c \leq a \mid n, p] + Pr\,[c' \leq a' \mid a < c < r, kn, p]$$ where

Pa = Probability of Acceptance

Pr $[c \leq a \mid n, p]$ = Probability of Acceptance based on the First Stage

Pr $[c' \leq a' \mid a < c < a', kn, p]$ = Probability of Acceptance based on the Second Stage (for ChSP-4)

Pr $[c' \leq a' \mid a < c < r, kn, p]$ = Probability of Acceptance based on the Second Stage (for ChSP-4A)

The appendix spells these terms out mathematically.

Example

Assume that we are making item A. We test A by some destructive test. There are defect characteristics which are undesirable although they do not affect the functioning of A. Consequently, we assign an AQL of 5 percent. For economic reasons, we choose the following plan: n = 12, a = 1, k = 4, a′ = 4 and r = 3 and we decide that the (k—1) lots shall come after the lot under test. The results experienced and the decisions made are as follows:

STAGE 1		STAGE 2	
Results	Decision	Results	Decision
2	Defer	3	Accept
0	Accept	.	..
0	Accept	.	..
1	Accept	.	..
1	Accept	.	..
2	Defer	5	Reject
2	Defer	4	Accept
1	Accept	.	..
0	Accept	.	..
1	Accept	.	..
3	Reject	.	..

Effects on the OC Curve of Changing Values of the Sampling Plan

The effects on an OC curve of changing the sample size and the acceptance number are well known. In ChSP-4, these differences in sample sizes are made more graphic as can be noted in Fig. 1 and Table I where we note the sharper or steeper OC curve arising from the use of a larger n in Plan (b) versus Plan (a) although the same acceptance numbers are used in their First Stages. The effect of changing the size of the Second Stage by changing k is illustrated in Fig. 2 and Table I where we note only a slightly more favorable OC curve as a result of doubling the

Table I—ChSP-4 Sampling Plans

Plan Parameters	First Stage	Plan a	Plan b	Plan c	Plan d
n	12	12	24	12	12
a	1	1	1	1	1
k	..	8	8	4	4
a′		6	15	4	4
r	2	7	16	5	3
AQL	.05	.05	.05	.05	.05
Fraction Defective (p)		Probability of Acceptance (Pa)			
.03	.951	.994	1.000	.994	.991
.05	.882	.947	.981	.962	.954
.07	.797	.849	.806	.892	.881
.10	.659	.677	.391	.735	.725
.15	.443	.444	.108	.470	.466
.20	.275	.275	.033	.281	.280
.25	.158	.158	.009	.159	.159
.30	.085	.085	.002	.085	.085

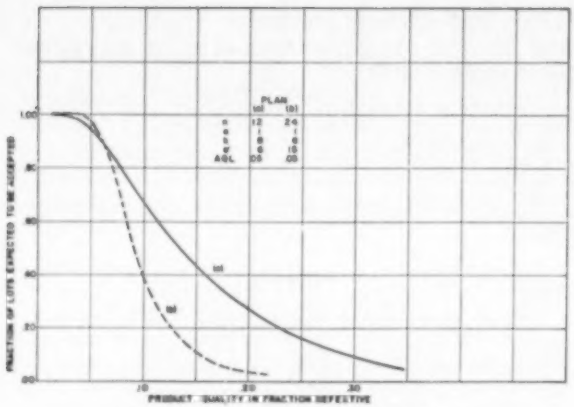

Fig. 1—Effect of Changes in Sample Size

total sample size (i.e. for the First and Second Stages combined) in Plan (a) as contrasted to Plan (c). This seems to indicate that the OC curve is "formed" by the First Stage whereas the Second Stage adds on the desirable refinement particularly in the region of the AQL value.

The effect of introducing r is shown in Fig. 3 and Table I. There, by comparing Plans (d) and (c), we note that a moderate change in the rejection number in the First Stage causes little change to the OC curve. It should be noted that this result is typical of most attribute double-sampling plans in which the rejection number for the first sample is greater than the

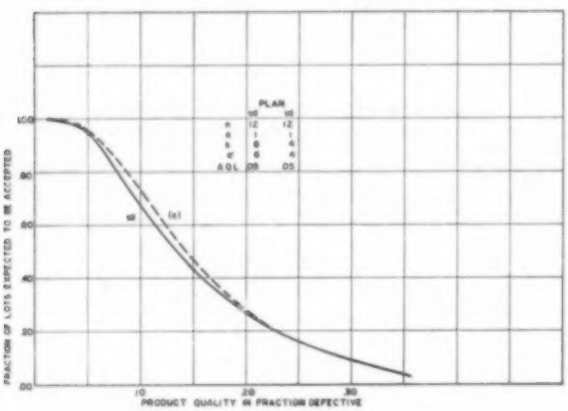

Fig. 2—Effect of Change in Size of Second Stage

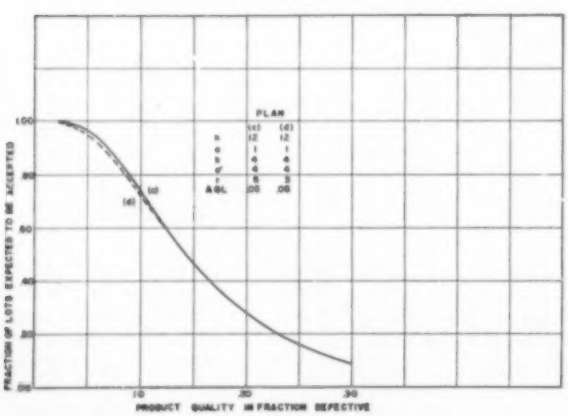

Fig. 3—Effect of Change in Rejection Number

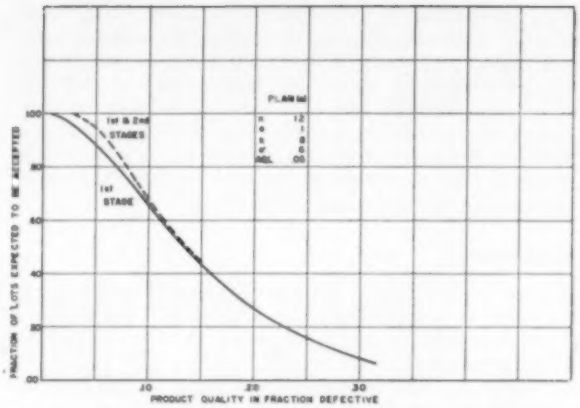

Fig. 4—Effect of Adding the Second Stage to the First Stage

acceptance number for the two samples combined. In Fig. 4 and Table I we show the effect of adding the Second Stage to the First Stage. This clearly depicts the beneficial effects of Chain Sampling.

Appendix

1. The OC curve for ChSP-4 is defined as

$$P_a = \sum_{x=0}^{a} \binom{n}{x} p^x(1-p)^{n-x} + \sum_{x=a+1}^{a'} \binom{n}{x} p^x(1-p)^{n-x} \times \sum_{y=0}^{a'-x} \binom{kn-n}{y} p^y(1-p)^{kn-n-y}$$

where

n = sample size of First Stage
a = acceptance number of the First Stage
k = number of lots in the First and Second Stages combined
a' = acceptance number for the k lots combined
p = fraction defective.

2. The OC curve for ChSP-4A is defined as

$$P_a = \sum_{x=0}^{a} \binom{n}{x} p^x(1-p)^{n-x} + \sum_{x=a+1}^{r-1} \binom{n}{x} p^x(1-p)^{n-x} \times \sum_{y=0}^{a'-x} \binom{kn-n}{y} p^y(1-p)^{kn-n-y}$$

where

r = rejection number of the First Stage.

References

(1) Dodge, H. F., "Chain Sampling Inspection Plan," Industrial Quality Control, Vol. XI, No. 4, January, 1955, pp 10-13.

(2) Navy Department, Bureau of Ordnance, NAVORD INSTRUCTION 8510.40, "Standard Sampling Plans for Torpedo Group Proving," Nov. 12, 1954.

Quality Control And PEOPLE

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AS a general activity of mankind, Quality Control can be said to influence *all* of us. In such terms of reference, we may think of it as embodying any act or thought directed to the improvement of life as we know it. It was just this reasoning which caused me to write as I did on the single occasion when I was asked to furnish prefactory remarks for a new textbook on the principles of Statistical Quality Control. All at once I was confronted with the need to convince myself about what *I* personally considered to be the significance of Q C principles. The thoughts I expressed for that preface three years ago are the same as I hold today:

> "For the individual who would read this book, I commend it on a strictly personal basis. The contents, properly absorbed, can build you into a bigger and finer person.
>
> "As the principles herein described are made a part of your everyday life—personal and business—you will sense a philosophical expansion that simplifies much of life's complexities.
>
> "Our problems in life are seldom nothing more or less than *excessive* variations from facility capacities (human and material). Statistical Quality Control methods afford a powerful medium for measuring, understanding, and finally improving control over these excesses."

Now this certainly is the very broad viewpoint, one that obviously goes far beyond the frequently limited understanding of Statistical QC as found in our industrial realms. But this is precisely my purpose—to pose the challenge that we as practitioners are performing inadequately if we fail to recognize and make use of the broader scientific and philosophical aspects of improving our lives through the techniques of Statistical Quality Control.

In the *Harvard Business Review* (September-October, 1954), Irwin Bross stated that the unusual mating of business and science has been "an association that not only is largely responsible for the technological world in which we live, but has led to the most important (and least publicized) intellectual achievement of the twentieth century—Statistical Decision." To this I modestly murmur an amen. Further, however, I should like to urge attention to the associate thought; namely, that Statistical Decision comes *only* from the measured data of variation, and variation is a characteristic which is inescapably present in everything we know in this world! Couple with this idea the use of the control chart, and you have a powerful principle uncovered by today's academic and scientific brains.

To develop this theme a bit, I should like to discuss briefly the specific people who are influenced by Quality Control and to accent the impact which practice of the techniques can have in four distinct areas of world society; that is, the industrial community, personal, and international.

Foremost of the groups of people I have in mind is that which is made up of the Quality Engineers themselves. It comprises the QC practitioner who is known variously as engineer mathematician, teacher, superintendent, laboratory technician, etc. These form the life blood of the activity. They are the preachers of the faith and the doers of the deeds. Theirs is the responsibility to dream bigger and better dreams—then to translate the dreams to practical benefits within our industrial and social environment.

Whether your job is to reduce scrap from variability in a forging process, to control volume in filling containers, to produce electrical units with maximum life and minimum waste, to control inventory discrepancies, to maximize supervisory output, or to teach the significance of variability and the relationship therewith to the laws of probability—basically, your objective and mine is to strive for better methods and materials with which to improve our world. It is our responsibility to show society about us the importance of *knowing* the extent and nature of defective elements in our productive efforts—and then demonstrate the need for reliable measurement, analysis, and action related to the data observed. Tied closely with this is the obligation, also, for making clear that variability within and between men is as much to be expected as differences within and between material elements, Recognizing this, and *doing some-*

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thing about it, is the equivalent of taking a long and important step toward improved understanding in our personal and social relations.

Are these worthy objectives for the quality engineer?

Would their ultimate accomplishment make the pioneering strife worth the effort?

My humble opinion says that the work of the true Quality Control man has an impact from one end of the world to the other. In one instance, he is helping to guide quality for the local enterprise; in another, his ingenuity and perseverance makes critical contribution through reliability determination in the fantastic era of missiles and space that we now enter.

Are you as intrigued as I am about the importance of Statistical Quality Control techniques as applied to reliability in missiles, rocketry, and nuclear facilities? It seems only too clear that the nation which provides optimum reliability in such machinery will hold the trump hand on both this sphere known as earth and on the inter-planetary highways of the future. How can we possibly overstate the part played by our people in this reliability field?

THE second group of people influenced by Quality Control I would think of as the executive and supervisory levels. It is usually the first of this group that is called upon to support or reject the use of Statistical QC principles. Frequently the executive, without benefit of technical understanding, is asked to have great quantities of faith in the methods. He can be a real hero if he guesses right. He must also accept the blame, of course, if the decision is wrong and only confusion and monetary loss result from experiments which are urged. From one side, the executive may recognize a need for more accurate measurement of waste factors in order to learn more about, and to better control, the process. He must always suspect that his competition is doing just this to gain a possible market advantage through price drop which could result from defect reduction. In balancing the perspective, however, this same boss must be ever alert to avoid having his operations dissipated through "systems." He must decide when the organization produces quality just for quality's sake—without regard to cost and effort involved, and at the same time he is expected to know when quality must be achieved at literally any cost. To this executive who keeps us in our jobs, we, as QC people, owe our best. We must help him to maintain reputation within the industry and in the specific community which is being served.

The secondary branch of this group is made up of the varying levels of supervision who keep the operation going. The tact and ability with which they direct adherence to established QC applications and urge new ones will determine to a large degree the benefits derived. Their basic attributes must be a desire to know the subordinate personnel and a capacity to "wear well" with them.

Let me say at this point that of all the highly commendable achievements credited to Statistical Quality Control, there is one with a powerful potential which as yet has been but lightly explored. This is related to SQC's capacity for placing many of our complex and trying business relationships on a sounder human basis. Especially does this apply to the area of employer-employee, or supervisor-worker relationships.

The phrase "all natural phenomena vary" distinctly applies to the thoughts and behavior of people—all people. "To err is human" could be accurately paraphrased—"To VARY is human." Such is the simple but important truth—one that all levels of industrial men would do well to place high in their philosophy of management. For whether they like it or not, and despite all their preventive efforts within economic reason, errors (variation) will exist to a greater or less degree. Now the provocative feature of associating this bit of philosophy with the methods of Statistical Quality Control is that the latter provides a means of measuring the *extent* of errors or defection and ultimately analyzing for an acceptable level of control. If the supervisory force is successful in making the translation of these scientific methods to the industrial, social, and personal phases of the employee body in general, it will have made a most worthy contribution to both community and personal interests of the organization.

NON-MANAGEMENT employees form the third group of people influenced by Statistical Quality Control. Often, like top management, they are asked to accept and participate in SQC applications with little knowledge of how or why they work, or even what they are expected to accomplish. Lacking proper indoctrination, this group will sometimes logically suspect that the methods have been designed specifically as a management device for unrealistically policing their work. Under these conditions, they naturally go on the defensive, and a continued cooperative performance is difficult to obtain. If, however, introduction is wisely made, the worker soon learns that use of the techniques can be of distinct benefit to him, personally. Particularly gratifying are those instances in which the full range of Quality Control philosophy is applied. In such cases, the employee begins to realize that management is practicing a belief which agrees that the cold, hard dictum of "Perfection" in effort is not a reasonable expectancy. When management makes this clear, as well as acknowledges a "natural limitation" to human endeavor, the chances are good that a new and stronger bond of understanding and cooperative effort will spring up between the two groups. With this, tensions will often subside. The employee will see that he is not being criticized for errors in a limited amount, and removing this type of mental barrier should result in more efficient production.

I have a tendency to accent this factor because it represents one of the most important psychological elements which motivate men. A simple concept, yes. Unfortunately, though, this very simplicity often belies the strength of the principle. Somehow, it is expected that doctrines

of this sort must be complex to have value. If only we could understand in this connection that the SQC viewpoint is a sort of scientific expression of the Golden Rule, "Do unto . . ."—and expect that your fellowman is as fallible as you know yourself sometimes to be—then acceptance might come easier.

Many of us have known the joy of bringing identification to the individual worker through the control charts of SQC. We have seen attention focused on him as he works in the center of the stage. This has not been too common, you know, during the past decade as automation rapidly spread through industry. Instead, individual identity has been increasingly obscured—causing the employee to lose that sense of "belonging." To the average man, this is a serious loss. Through the aid of control charts and data sheets, however, often we have been able to bring the man back into the picture. On these occasions, we are repeatedly taught that recognition, in whatever may be our endeavors, is a basic need of man. You want it—I want it!

While most of us know how the SQC tools help the employee to produce a better product, I wonder how many fully utilize the opportunity for also returning to him pride in effort? How much more can be gained by taking the worker out of the machine category and by ascribing recognition to the individual qualities of the *man*. This surely can have a great psychological benefit to a large segment of America's work force.

Throughout the broad domain in which the Statistical QC principles operate, the final arbiter of the quality effort is the consumer. He forms the fourth and last specific group of those peoples influenced by the movement. By simple acceptance or rejection of services or products rendered, he judges incontrovertibly whether or not the quality effort has been successful. Obviously, we are all members of this group.

In its ultimate purpose, the work of SQC can have but one real goal—the enrichment of the consumer's existence. The pattern for this is generally one of measuring, isolating, and limiting defective elements in his environment. I personally view this as a great gift to society. Not that the goal of enriching man's life was absent prior to the advent of Statistical QC. There is little doubt that the will to enhance living standards is as old as the history of man itself. That which *is* new, though, is Walter Shewhart's control chart method of treating statistical data in such manner as to be able to distinguish between "assignable" and "chance" causes in life's variability—and therewith bring a reliable, scientific method for working at the problem.

HOW many of us really *understand* the tremendous potential herein for limiting the "excesses" of our world! It seems to me that the effects easily reach from community to national and international boundaries. They can be recognized in the pure enjoyment of higher standards in the personal and community life, and they stretch internationally and even to the exciting provinces of outer space—where cold truth points to *RELIABILITY* as the key. And here, once again, I remind you of the vital role SQC'ers play in the development of our space machinery.

We face a most challenging test. Whether or not we capitalize on the opportunity remains to be seen. In giving just one man's opinion, however, I humbly suggest that before we can hope to experience the fuller benefits of our work, we must strive for a *broader* scientific and philosophical interpretation of Statistical QC than is found now in many of our local offices. We must seek to understand more completely the basic influence these principles have on mankind in general and on the specific groups that have just been described. When this is accomplished, we will have realized one of the richest attributes associated with Shewhart's fundamental concept of control.

In my enthusiasm for the SQC values, I trust you will not wrongly believe that I suggest them as the single remedy for the world's ills. Really, I am not that naive. I do belive, though, that as Statistical QC people we have much to offer, and we should make the most of our opportunities. To do so, requires seeing the entire picture. Statistical QC *does* influence all of us—from the smallest to largest aspect of our living. As we move along in the work, our attention must not be limited to variability in material things, but it must also take account of the social influence. Man's propensity to err (vary) is natural, and it becomes a mutually constructive effort for all to make the best we can of life with what we have. Statistical QC enables us to learn more than we previously knew about the world's limitations and points the way to optimizing effort within the limits.

In this field of Scientific Quality Control the members of ASQC have a major role. You both formalize its meaning and usefully disseminate its values. I am sure you can become philosophically attuned to better understand and make more profitable application of these principles which affect us all.

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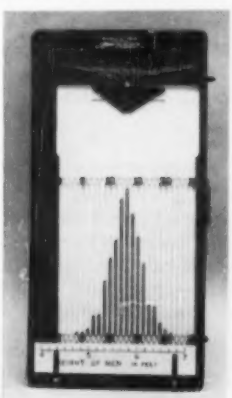

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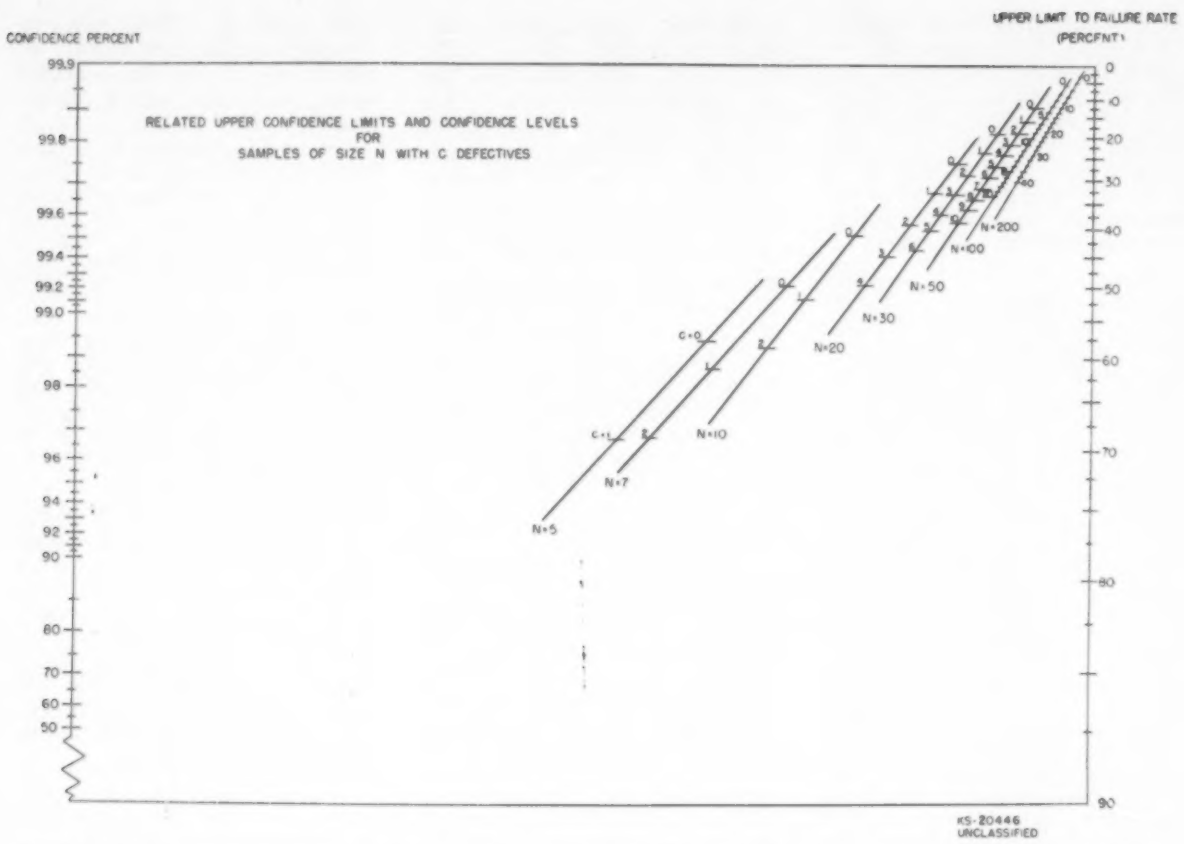

A Nomogram For Upper Confidence Limits To Percent Defective

A. L. HARDESTER and G. L. BURROWS, ***General Electric Co., Knolls Atomic Power Laboratory, Schenectady, N. Y.***

ANYONE who was not too dismayed at the outcome of his first experiment to dare to do another needs no reminder that it is difficult to repeat an experiment and reproduce the original results exactly. Part of the discrepancy may be due to failure to reproduce exactly the earlier experimental conditions, but part is often due to inherent characteristics of what is being measured. Two autoclave tests, each on 30 specimens from the same ingot, may show different numbers of cracked specimens. One sample of five elements from a batch of reactor fuel elements may turn up no defective elements whereas a second sample of five from the same batch may yield a defective. Experimenters expect some differences and are surprised when they do not show up. But, there is a limit to the size of the differences they expect.

Statistical confidence limits, statistical tolerance limits and statistical tests of hypotheses caution us against misinterpreting the results of experiments. Thus the difference between two autoclave tests on specimens from different ingots would be pretty weak evidence of the superiority of one ingot if equally large differences could be expected from two tests on specimens from the same ingot. No defective elements in a sample of five from a batch of 800 will hardly convince us that there are no defective elements in the entire batch because, even if there were 100 defective elements in the batch, the odds are against our finding one in a sample of five.

Any number of discussions, tables and charts exist to guide experimenters in the use of these statistical tools.*

One problem occurs again and again. Fifty specimens of a particular type are tested and one fails. We estimate that 1 in 50 or 2 percent of such specimens will fail under similar circumstances. A failure may be a specimen that cracks or fails to meet some other tolerance, such as dimension or color or a combination of tolerances. A specimen that is defective

ASQC LCS Code 552:510:70:400

*See References

in any way or in any combination of ways may if desirable be interpreted as a failure. We may use the nomogram, Fig. 1, to go one step beyond the estimation of the long-run failure rate. With a straight edge join the observed experimental result, namely one failure in a sample of 50, that is, the point 1 on the N = 50 scale, with any desired point of the confidence percent scale, say 95 percent. The straight line intersects the far right hand scale at about 8½ percent. We conclude that on the basis of our experimental results we are 95 percent confident that fewer than 8½ percent of such specimens will fail under similar circumstances in the long run.

If we ask for less assurance we can lower our upper limit to the percent that will fail. For example the line joining 80 percent confidence with C = 1 on the N = 50 scale intersects the far right hand scale at 6 percent. We conclude that on the same experimental evidence we can assert either that we are 80 percent confident that fewer than 6 percent will fail in the long run or that we are 95 percent confident that fewer than 8½ percent will fail in the long run.

It is important to remember that these limits are not estimates of the percent of specimens expected to fail in the long run. The experimental evidence furnishes the evidence on the number expected to fail. A change in the assurance we require can't possibly affect either the number that will fail nor even the number we expect to fail in the long run. However, the more assurance we require the higher will be the upper limit to the percent that will fail in the long run.

To examine what effect a change in the experimental evidence has upon our upper limit to the percent of elements that will fail in the long run, we join the point of 80 percent confidence with the point C = 0, instead of the point C = 1, on the N = 50 scale. We see that the upper limit on the percent that will fail in the long run drops from 6 percent to 3 percent.

To learn the effects of a change in experiment size we join the point 80 percent confidence with C = 0 on the N = 100 scale instead of C = 0 on the N = 50 scale and see that the upper limit on the percent that will fail in the long run drops from 3 percent to 1.6 percent.

If we wanted to know how large an experiment to run in order that we could conclude with 95 percent assurance that fewer than 1 percent of specimens will fail in the long run we join the point 95 percent confidence on the far left hand scale with an upper limit to the percent that will fail of 1 percent on the far right hand scale. We see that more than 200 specimens would be required in the test even if no specimen failed during the test.

THE nomogram has been found more useful in our work than the charts or tables ordinarily used for the same purpose. The usual charts provide only selected confidence percents and are ordinarily printed on successive pages, which makes interpolation difficult. Our chart provides for an easy appraisal of the effect of change in sample size upon the magnitude of the upper confidence limit for fixed confidence percent or upon the confidence percent for fixed upper confidence limit for sample sizes up to 200, the number of defectives up to 20 percent of the sample size and for confidence percents in the most useful range of 80 to 99.9.

The maximum absolute error associated with the use of the nomogram is 2 percent in Failure Rate units. Errors this large occur rarely, and only for large C and

TABLE I—Maximum Absolute and Relative Percent Errors in the Failure Rate Scale

Confidence Level = 50%

C/N	N = 5		N = 7		N = 10		N = 20		N = 30		N = 50		N = 100		N = 200	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
0	1.0	7.8	0	0	0.5	7.5	0.4	11.8	0	0	0.1	7.1	0	0	0	0
0-.02											<0.5	<14.7	0.3	17.6	0.2	8.7
.02-.04									0.5	9.1	<1.0	<18.9	<0.5	<10.6	<0.5	<11.6
.04-.06							0	0			0.7	9.6	<0.5	< 8.8	0.7	13.2
.06-.08									0.7	8.0	0.7	7.5	0.4	4.7	0.2	2.7
.08-.10					2.0	12.3	0.8	6.1	0.9	7.4	1.2	10.6	0.5	4.7	0.2	1.9
.10-.12											0.7	5.3	0.4	3.4	0	0
.12-.14			1.1	4.8					1.5	9.7	0.8	5.3	<0.4	< 2.9	0	0
.14-.16							1.9	10.5			0.8	4.7	<0.4	< 2.6	0	0
.16-.18									0.8	4.3	<0.8	< 4.2	0.4	2.3	0	0
.18-.20	0.5	1.6			1.4	5.4	2.0	8.7	1.0	4.5	1.3	6.1	0	0	0	0
.20-			1.1	3.0												

Confidence Level = 99.9%

0	1	1.1	1.3	1.5	0.6	0.8	<0.8	2.7	<0.4	1.9	0	0	0.2	2.9	0	0
0-.02											0	0	0.1	1.1	0	0
.02-.04									0	0	0	0	0	0	0	0
.04-.06							0	0			0.2	0.8	0.5	2.9	0	0
.06-.08									0.3	0.9	0.1	0.4	<0.5	< 2.7	≈0.5	≈ 2.9
.08-.10					≈1.6	2.6	<1.2	2.7	0.1	0.3	<0.6	< 2.0	<0.8	< 3.8	0	0
.10-.12											0	0	0.9	3.6	≈0.5	≈ 2.4
.12-.14									0.2	1.9	<0.4	< 1.2	1.1	4.2	<1.0	< 4.5
.14-.16			1.7	2.2			1.5	2.9			1.0	2.7	1.2	4.2	1.0	3.8
.16-.18									0.7	1.5	≈0.5	≈ 1.3	1.8	5.8	<2.0	< 7.1
.18-.20	0.1	0.1			0.1	0.2	2.0	3.5	1.4	2.9	1.2	2.9	1.8	5.2	≈1.5	4.3
20-			0	0												

A = Absolute Percent Error; R = Relative Percent Error

confidence levels near 50 percent, where the results are of least practical interest, and at high (99.9 percent) confidence levels with large C, where the relative percent error in failure rate is quite small. When C is small, the absolute error is negligible whereas the relative error, as might be expected, is large. A more detailed account of these errors for the two worst cases is given in Tables I and II. The errors listed are all positive; thus the nomogram yields conservative upper confidence limits to the failure rate.

It may be worth noting that the nomogram has another important application, namely in setting nonparametric statistical tolerance intervals. For example, the point C = 3 on the N = 100 scale is on a line with the points 80 percent confidence on the left-hand scale and 5½ percent defective on the right hand scale. It also lies on a line with 95 percent confidence and 7½ percent defective. For any measured characteristic of the tested specimens we can simply read the far right scale as population coverage instead of percent defective and conclude

1. With confidence at least 80 percent that 100 − 5½ = 94½ percent of specimens will in the long run exhibit values of the characteristic lying below the 97th, between the 1st and the 98th, 2nd and 99th or greater than the 3rd among the observed measurements ordered from the least to greatest.

or

2. With confidence at least 95 percent that 100 − 7½ = 92½ percent of specimens will in the long run exhibit values of the characteristic lying below the 97th, between the 1st and 98th, 2nd and 99th or greater than the 3rd among the observed measurements ordered from least to greatest.

In general for confidence percents, C's and coverages lying on a line the end points of the statistical tolerance interval can be taken to include any C of the outermost (i.e. combined least and greatest) observed test measurements.

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List of Short Courses in Quality Control

Usual Time Course is Held	*Type of Course*	*Where Held*	*Course Director*
February	Basic	University of Illinois, Urbana, Ill.	J. A. Henry
May	Basic (Textile)	North Carolina State College, Raleigh, N. C.	D. B. Stansel
June	Basic	Marquette University, Milwaukee, Wis.	Gayle W. McElrath
June	Advanced	Purdue University, Lafayette, Ind.	I. W. Burr
June	Basic (Graphic Arts)	Rochester Institute of Technology, Rochester, N. Y.	Harold Kentner
June	Basic (Chem. Ind.)	Rochester Institute of Technology, Rochester, N. Y.	R. D. Pease
June	Advanced (Chem. Ind.)	Rochester Institute of Technology, Rochester, N. Y.	R. D. Pease
July	Op. Research	University of Michigan, Ann Arbor, Mich.	Oscar Wesler
July	Basic	TAPPI Statistics Conference	M. S. Renner
July	Advanced	TAPPI Statistics Conference	M. S. Renner
July	Advanced	University of Oklahoma, Norman, Okla.	R. L. Huntington
August	Basic (Research)	North Carolina State College, Raleigh, N. C.	.....
August	Advanced (Research)	North Carolina State College, Raleigh, N. C.	.....
August 15-25	Basic	University of Michigan, Ann Arbor, Mich.	C. C. Craig
August 1-19	Basic	U.C.L.A., Los Angeles, Calif.	Edward Coleman
August 1-19	Advanced	U.C.L.A., Los Angeles, Calif.	Edward Coleman
Aug.-Sept.	Basic	University of Connecticut, Storrs, Conn.	R. M. Story
September	Basic	University of Mississippi, Oxford, Miss.	Gayle W. McElrath
October	Basic	State University of Iowa, Iowa City, Iowa	L. A. Knowler

LINEAR CONTRASTS

Part I

CHESTER H. McCALL, JR.
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Introduction

A CLASSICAL problem which plagued applied research technicians for years was what to do in an analysis of variance study to detect specific significant differences existing among a set of k-means. While today this problem has not been evaluated in a definitive way, there are at least some alternative procedures available to the experimenter. The existence of a set of alternatives always brings forth the vital question "Which is most appropriate to use under what set of conditions?" This series of articles will present four "popular" procedures and a discussion of the merits of each process.

Before examining these techniques, a few introductory remarks are in order. To apply linear contrast procedures requires that the classification being used is a Fixed, or Analysis of Variance (referred to as ANOVA) classification. Such a design assumes that the variable(s) of classification under study are all represented in the experiment. For example, in a given plant it is desired to test the tolerance of a product made on ten machines operated by 20 men, ten on each of two shifts. Using each machine and each man on each shift would constitute an ANOVA model. If only a sample of machines (say four) and a sample of men (say four on each shift) were used in the study, the Components of Variance or Random Model is being used.[2,3,4,5,7,11]

It has now been determined that the experimental design must be such that the effects (classifications) being examined are fixed.

Attention is turned to a definition of a contrast and its estimate in a set of sample statistics. Let

$$\theta_j = c_{1j}\mu_1 + c_{2j}\mu_2 + \ldots c_{kj}\mu_k \qquad (1)$$

such that

$$\sum_{i=1}^{k} c_{ij} = 0,$$

where θ_j is defined as the j-th contrast among the set of means in the population. An example of one contrast might be

$$\theta_1 = \mu_1 - \mu_2$$

Here $c_{11} = 1$, $c_{21} = -1$, and c_{31}, c_{41}, etc. $= 0$. This contrast is evidently the difference between the two population means. The coefficients, c_{ij}, are subjected to certain conditions depending upon the particular problem. In practice, it is of interest to estimate the population contrasts from experimental results. Let

$$\hat{\theta}_j = C_{1j}\bar{x}_1 + c_{2j}\bar{x}_2 + \ldots + c_{kj}\bar{x}_k \qquad (2)$$

be a sample estimate of θ_j, where $\bar{x}_i$ is an estimate of μ_i.

Orthogonal Contrasts

The four procedures discussed in this series utilize different linear contrasts and somewhat different assumptions. A special set of linear contrasts is referred to as orthogonal. If, for equal size samples (see reference (9) for unequal sample sizes), it is true that

$$\sum_{i=1}^{k} c_{ij}c_{im} = 0 \qquad j \neq m \qquad (3)$$

then the contrasts are referred to as orthogonal. For a given experiment, it is possible to determine a set of orthogonal contrasts such that the sum of squares of these contrasts will add up to the sum of squares

ASQC LCS Code 523:00:000
Parts II and III will be published in the August and September issues, *Industrial Quality Control*.

for the given effect. For example, the ANOVA Table for the experiment listed in Hicks' article,[8] yields the following table:

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Sum of Squares
Between Methods	651.95	1	651.95
Among Groups	16.05	2	8.02
(Method) × (Group)	1.19	2	.60
Among teams within groups	39.26	6	6.54
(Method) × (team within group)	10.72	6	1.79
Residual	41.59	18	2.31
Total	760.76	35	.....

The three groups are found to be significantly different when the usual F ratio is computed. Since the among groups has two degrees of freedom, it is possible to break down this sum of squares into sums due to two orthogonal contrasts. Two possible contrasts are:

$$\theta_1 = \bar{x}_1 - \bar{x}_3$$
$$\theta_2 = \bar{x}_1/2 - \bar{x}_2 + \bar{x}_3/2 \qquad (4)$$

The contrasts are orthogonal, since they meet the requirements of (1) and (3), namely:

$$1 - 1 = 0$$
$$1/2 - 1 + 1/2 = 0$$
$$(1)(1/2) + (0)(-1) + (-1)(1/2) = 0$$

The sum of squares due to each contrast,[9] is given by

$$\text{S.S. } (\hat{\theta}_j) = \frac{\hat{\theta}_j^2}{\Sigma c_{ij}^2/n} \qquad (5)$$

For the two contrasts:

$$\text{S.S. } (\hat{\theta}_1) = \frac{(20.125 - 18.492)^2}{1/12\,(1 + 1)} = 16.01$$

$$\text{S.S. } (\hat{\theta}_2) = \frac{(10.063 - 19.383 + 9.246)^2}{1/12\,(1/4 + 1 + 1/4)} = 0.04$$

There is, however, an inherent weakness in this method. Only one of a set of possible orthogonal contrasts has been selected. Others might have been selected. For example, another possible set would be

$$\hat{\theta}_3 = \bar{x}_1 - \bar{x}_2$$
$$\hat{\theta}_4 = \bar{x}_1/2 + \bar{x}_2/2 - \bar{x}_3 \qquad (6)$$

Therefore, the problem narrows down to the selection of the set of contrasts which are to be used. It should be evident that, for an experiment using even five samples, there exist a large set of orthogonal contrasts. It is generally accepted that the particular set of orthogonal contrasts should be selected prior to an experiment. This will allow a test of significance on each contrast, using one degree of freedom.

Often, however, it is impossible, if not impractical, to select the set of contrasts in advance of an experiment. In fact, the results of many experiments suggest meaningful comparisons. It seems appropriate, therefore, to introduce at this time a method which allows for the analysis of *all possible* contrasts in an ANOVA design.

The Method of Henry Scheffe

Henry Scheffe[10] introduced a procedure for testing the significance of any and all linear contrasts in an analysis of variance model. The procedure is first outlined here and then several examples presented.

As in equation (1), θ_j is defined as the population contrast and $\hat{\theta}_j$ as the sample estimate of this contrast. It is known, if the x_i's are independent (this is not too important in a practical sense), that

$$\text{Variance } (\hat{\theta}_j) = \sum_{i=1}^{k} c_{ij}^2 \sigma_{\bar{x}_i}^2 = \sigma_{\hat{\theta}_j}^2 \qquad (7)$$

Since $\sigma_{\bar{x}_i}^2$ is usually unknown, it is necessary to estimate this term by the following

$$\hat{\sigma}_{\hat{\theta}_j}^2 = \sum_{i=1}^{k} c_{ij}^2 \hat{\sigma}_{\bar{x}_i}^2 \qquad (8)$$

It is also known that the estimate of $\hat{\sigma}_{\bar{x}_i}^2$ is given by

$$\hat{\sigma}_{\bar{x}_i}^2 = \hat{\sigma}^2/n_i = \frac{\text{residual mean square}}{n_i} \qquad (9)$$

where the residual mean square (sometimes referred to as error mean square) is the unbiased estimate of σ^2 in the ANOVA model (i. e., the denominator of the F ratio for testing the desired effects).

Scheffe goes on to state that the contrast $\hat{\theta}_j$ is significantly different from zero whenever

$$|\hat{\theta}_j| > A\hat{\sigma}_{\hat{\theta}_j} \qquad (10)$$

where

$$A = \sqrt{(k-1)\,F_{\alpha(k-1,n_2)}} \qquad (11)$$

In equation (11), k = number of means involved in the classification being studied; and, $F_{\alpha(k-1,n_2)}$ = the table F at the α-level of significance, for $(k-1)$ and n_2 degrees of freedom (n_2 being the degrees of freedom associated with the residual term, as defined above).

It is interesting to note that for the special case $k = 2$, equation (10) becomes the well known comparison for two sample means, namely:

$$|\bar{x}_1 - \bar{x}_2| > t\hat{\sigma}\sqrt{1/n_1 + 1/n_2}$$

where t has $n_1 + n_2 - 2$ degrees of freedom.

If at least one $\hat{\theta}_j$ is significantly different from zero, then the original F test rejects the null hypothesis. If no $\hat{\theta}_j$ is significantly different from zero, then the original F test does not reject the null hypothesis.

Example 1: In (1) measurements were made on 96 steel bars using two heat treatments, four machines, three time periods, and four replications per experimental combination. The analysis of variance yielded a significant difference among the four machines. The average measurements for the four machines (in inches) were reported:

Machine	C	A	D	B
Average	0.9	3.4	5.7	5.9

The residual term in the analysis of variance was six and the Table F for (3,9) degrees of freedom

at the 0.05 level is 2.71. Using this information the contrasts $\bar{x}_i - \bar{x}_j$ can be examined using the standard error suggested by formulas (8) and (9), namely:

$$\hat{\sigma}^2_{\hat{\theta}} = \hat{\sigma}^2(1/n + 1/n)$$
$$= 6(1/24 + 1/24) = 0.5$$
$$\hat{\sigma}_{\hat{\theta}} = 0.71$$

Further, from (11)

$$A = \sqrt{(4 - 1)\, 2.71} = 2.85$$

Therefore, a contrast between two means is significant if

$$| \hat{\theta} | > 2.85 \times .71 = 2.02$$

Examining the data, B and D are not significant, while all other pair-wise comparisons are.

Example 2: In (6) measurements were made in a Graeco-Latin Square, replicated four times. The variable (measured in inches of water rise up a cylindrical tube with a radial area of one square inch) showed a significant difference among machines and among operators. Since two machines were hand operated and two were foot operated, it was important to pinpoint the heterogenity among machine means. The average measurements for the four machines were reported:

Machine	1	2	3	4
Mean	39.84	39.88	41.13	41.28

Here, the residual term was 1.133 and the Table F at the five percent level for 3 and 30 degrees of freedom is 2.92. From this information, pairwise differences for the above means can be examined, using formulas (8) and (9), namely:

$$\hat{\sigma}^2_{\hat{\theta}} = \hat{\sigma}^2(1/n + 1/n)$$
$$= 1.133(1/16 + 1/16) = 0.142$$
$$\hat{\sigma}_{\hat{\theta}} = 0.377$$

Further, from (11)

$$A = \sqrt{(4 - 1)\, 2.92} = 2.85$$

Hence, a contrast between two means is significant if

$$| \hat{\theta} | > 0.377 \times 2.96 = 1.12$$

Examining the data, pairwise, 1 differs from 3 and 4; and, 2 differs from 3 and 4. 1 and 2 are homogeneous, as are 3 and 4.

A further comparison can be made here. It is of interest to note how the average for machines 1 and 2 differs from the average for machines 3 and 4. The contrast becomes

$$\hat{\theta} = 1/2\ (39.84 + 39.88) - 1/2\ (41.13 + 41.28)$$
$$= 1.35$$

The estimated variance for this contrast becomes

$$\hat{\sigma}^2_{\hat{\theta}} = \hat{\sigma}^2/4\ (1/16 + 1/16 + 1/16 + 1/16) = 0.0708$$
$$\hat{\sigma}_{\hat{\theta}} = 0.266$$

The value for A remains 2.96

Hence, the contrast just defined is significant provided

$$| \hat{\theta} | > 0.266 \times 2.96 = 0.787$$

Significance obviously exists here.

The method of Henry Scheffe, then, has provided two types of comparison: pairwise and groups.

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From the Scrap Box

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Certificates of Compliance

H. K. JOHNSON, *Good-All Electric Manufacturing Co., Ogallala, Nebr.*

Any company that has sold products to be used by a Governmental agency, and particularly the Armed Services, is more than casually acquainted with certificates of compliance.

These certificates are simple statements, presumably signed by a responsible officer of the company, to the effect that the referenced product meets the buyer's requirements. Depending on a variety of circumstances, the certificate may state that the product meets the requirements of one or more of the following:

A. a specific purchase order
B. a drawing
C. a specification
D. all requirements
E. all applicable Government and Military specifications
F. manufacturer's specifications (sorry, no copies available)
G. test reports, which are on file.

The statements are usually signed by one of the following:

A. President or Vice-President
B. General Manager
C. Sales Manager
D. Production Foreman
E. Inspector
F. Secretary or Switch Board Operator

They may or may not be witnessed or notarized.

The intent of the certificates of compliance is to assure quality. The reasoning behind this method goes something like this: "the supplier will double-check or take additional precautions if he knows that he will have to sign a statement indicating conformance without reservation". The fact that this reasoning is not valid is a matter of history.

Let us consider three examples:

1. Joe makes screws. He got an order for a military standard screw which is very nearly the same as a commercial screw that he has in stock. Joe shipped the commercial screw and blithely sent his certificate of compliance. The screws appear nearly enough alike so that Joe was sure no one would ever catch him. They didn't, the first time!
2. Bill makes nuts; his order for MS nuts was made in a special run. He ordered special steel, and samples were checked for analysis and properties. All production stages were carefully checked. The final product was thoroughly gaged. Bill personally signed the certificate of compliance, certain that he had met all requirements. The receiving inspector at the buyer's plant didn't think the plating was quite as bright as it should be and the parts were rejected!
3. Don makes coat hooks. He received an order for a quantity of coat hooks, specifying his catalog number. His catalog shows shape, approximate size, and specifies commercial material. After receiving the order, the buyer called Don (long distance, collect), to inform him that the parts could not be accepted unless he forwarded a certificate of compliance stating that the parts met all applicable military specifications. Don argued that, to his knowledge, the parts met no military specifications, but to no avail. He sent the certificate. An eager inspector at the buyer's plant, looked through a specification index until he found a likely specification to check the material against. Poor Don!—he hadn't considered building coat hooks from 52100 steel per MIL-S-7420B.

These examples are not intended as humor—many similar instances just as ridiculous are a matter of record. The question is: What do the certificates of compliance accomplish? Do they have any effect on the acceptability of material? Do they have any effect on the quality of material? The answer is a flat **NO.**

The fact is that the basic characteristics of a human

ASQC LCS Code 350:70:000

University of Michigan Course

The University of Michigan has scheduled its thirteenth annual intensive course in Quality Control by Statistical Methods for Aug. 15-25, on the campus in Ann Arbor, Mich.

This is a basic, first course for executives and supervisory personnel; it is practical and mathematically non-technical. It includes the standard control charts and sampling acceptance plans together with other basic techniques.

For additional information, see Clinics, Conferences, and Courses, page 47, this issue.

being, including his integrity are not measurably altered because he has to sign a piece of paper which he considers insignificant.

An excuse for a certificate of compliance often heard is that "it provides legal recourse against the supplier if his material is not good enough. This is not a valid argument, and a very poor excuse. If the buyer has stated exactly what he wants on his order, he **has** legal recourse in the event that he receives something different. This was true long before the invention of the certificate of compliance. If the buyer receives something that is not just what he wanted, but he did not make his wants known on the order, the certificate of compliance cannot help him.

What do certificates of compliance cost? The answer is the sum of several factors. The direct cost of the signed piece of paper will vary between 50¢ and $1.25 each. Then there is the clerical work of recording and filing, the cost of storage for a few years, the cost of delays and communication if they are not immediately forthcoming. The biggest cost is accepting material, only to discover too late, that it is defective.

These costs are usually passed along to the end user through higher prices. To absorb the costs would be to decrease profits. Lack of profits is one reason for going out of business.

There are two aspects of the situation that give cause for concern:

1. Many companies, with complete approval of their customers, accept materials solely on the basis of certificates of compliance.
2. Many companies recently started a "total quality assurance program". Their QC people are zealously requiring certificates of compliance, both from their vendors, and from their vendor's vendors. This appears to be a case of copying what someone else has started, without adequate thought as to what they expect to accomplish. This has even been noted in companies whose products are wholly commercial—not military.

But the situation is not entirely black—a recent specification for quality control systems has been coordinated by the services (MIL-Q-9858). It is noteworthy that it contains no references to certificates of compliance.

One final word of advice: if you don't know what certificates of compliance are costing you, and if you don't know exactly the degree of protection you are getting, it is about time you got down to the receiving inspection area and found out!

Mathematical Research on Reliability Prediction

Summary Technical Report STR-2436, December 1959, U. S. Department of Commerce
National Bureau of Standards, Washington 25, D.C.

Summary

The National Bureau of Standards is engaged in probability and statistics studies basic to the prediction of system reliability. The results of this work can be used in evaluating the reliability of electronic computers, weapons systems, and other complex equipment.

Introduction

The improvement of reliability is one of the major problems facing current technology. Electronic computers, automatic control systems, and satellite instrumentation must operate with satisfactory reliability over relatively long periods of continuous or intermittent use. On the other hand, the electronic systems in guided missiles are required to withstand a long "shelf-life" yet perform with high reliability during their very brief period of use.

Because of the complexity of such systems, many unknown and uncontrollable factors influence their performance. Thus, some aspects of system performance have come to be treated as probabilistic phenomena. For quantitative evaluation, the reliability of a system may be defined as the probability of satisfactory performance under clearly specified conditions, including time of operation. The evaluation and prediction of system reliability accordingly require the development and use of probabilistic and statistical tools.

The National Bureau of Standards is studying problems in mathematical statistics and applied probability theory that arise in evaluating the reliability of complex systems. Emphasis is placed on alternative approaches to the construction of mathematical models for the organization of information on system design and component performance. This work, by J. R. Rosenblatt and M. Zelen of the Bureau's Statistical Engineering Laboratory, is complemented by the development of statistical techniques for analyzing experimental data on the reliability of components. The long-range goal of this program is to make available a spectrum of approaches to model construction and a variety of statistical techniques, with accompanying criteria for selecting the most suitable method for a particular application.

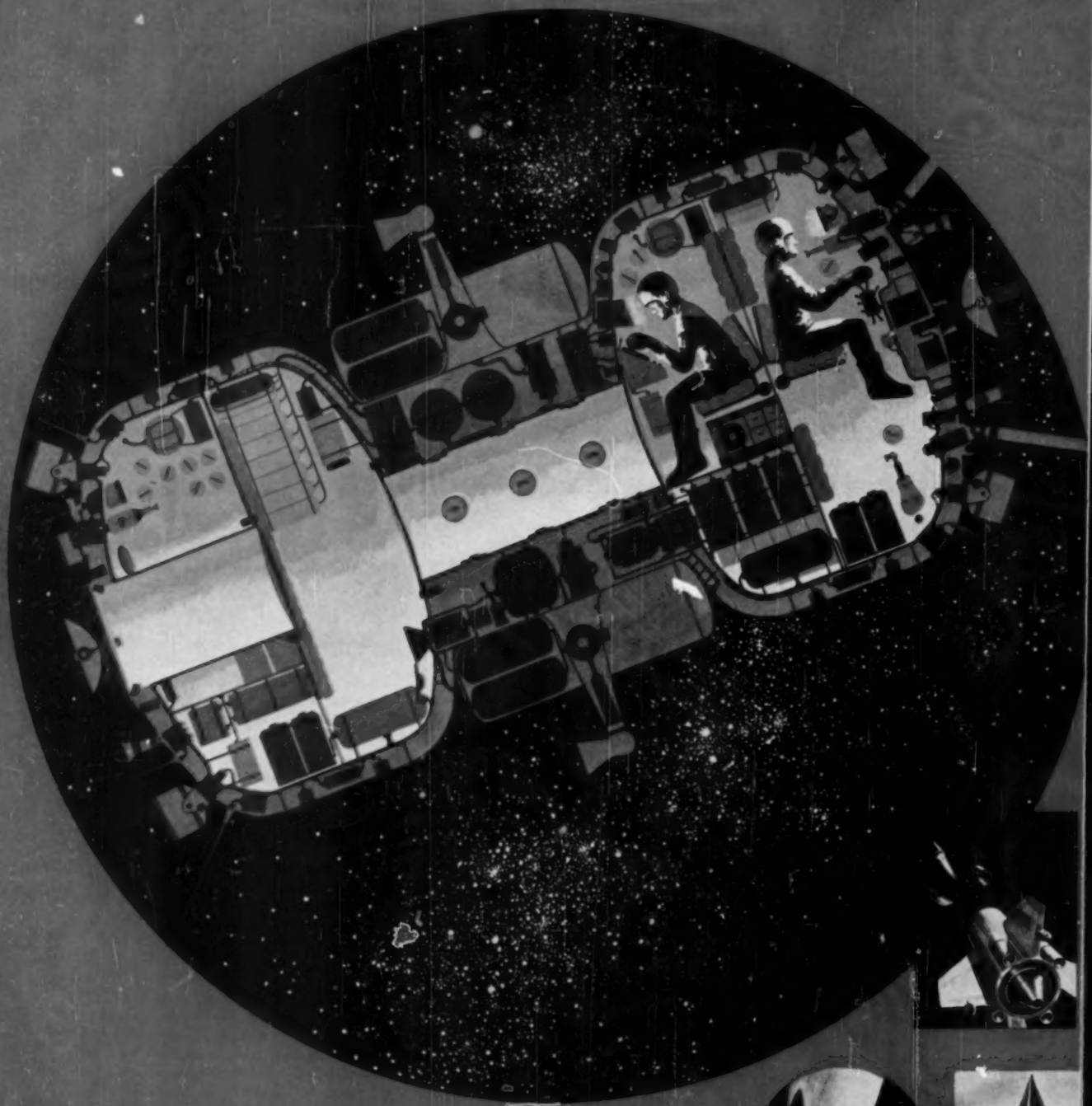
System Reliability

Evaluation or prediction of system reliability, especially at the research and development stage, depends on systematic utilization of engineering design information, data on component performance, and data on the conditions under which the system will be used. Studies at the Bureau have led to the formulation of a general framework for mathematical representation of causal or statistical interdependence of subsystems in a complex system.[1] This work provides a basis for the detailed treatment of the relation of system performance to properties of system design and component performance.

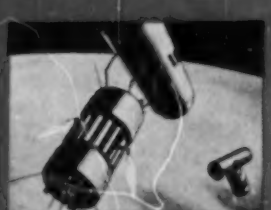
Within the general framework, various possible forms of relationships among subsystems have been

ASQC LCS Codes 821:831:60:436

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY



THE ASTROTUG



Tugboat for Space: Spaceborne scientific laboratories and platforms for further exploration into space are an accepted concept based on established engineering techniques. Components would be fired as individual units into space, on precalculated orbits, and there assembled. To solve the major problems of how men are to live and work in space during the assembly process, Lockheed has prepared a detailed engineering design of an astrotug—a manned vehicle housing a crew of two or three. Missile-launched, the astrotug will be capable of supporting its crew for a number of days in an environment of suitable atmosphere, and with provisions for exercise, relaxation, bathing facilities, medical care, illumination and adequate food and water.

The Lockheed astrotug is a completely independent working vehicle. Personnel need not leave it in space suits in order to work on the project of assembling the space station components. As shown in the diagram, the tug consists of two double-walled pressure vessels approximately 20 feet long overall and 9 feet in inside diameter. Swivelling rocket nozzles are arranged for maneuvering. On the forward end, extending out are four mechanical manipulator arms with interchangeable "hands" for such specialized functions as gripping, welding, hammering, cutting, running screws, etc. "Hands" can be changed by remote control from inside. Viewing ports provide uninterrupted observation. Radar antennas, searchlights, and other equipment necessary to the tug's work are mounted externally. Main controls and instruments including radar, radio, infrared, computers and navigation consoles are duplicated in each of the two major compartments as a safety measure.

Men working in single units afloat in space suits would have little applicable force and could work for very limited periods of time. With the Lockheed astrotug, personnel could carry on the work in relative safety and comfort with maximum efficiency. A special reentry vehicle, separate from the astrotug, has been conceived for ferrying to and from earth. Tugs themselves would remain floating in orbit indefinitely, being reprovisioned and refurbished as fresh crews arrive in relief.

Space vehicle development is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology—from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

Engineers and Scientists: Such programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. G-23, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

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studied. It was shown, for example, how analysis of system design and operating environments may lead to separation of environmental effects from other factors. When this can be done, subsystems may be found to be (statistically) conditionally independent under fixed environmental conditions. When conditional independence holds, the calculation of a reliability prediction will be simplified.

The classification of modes of failure is one of the preparatory steps in constructing a mathematical model for reliability prediction. The definition of different phases of the storage and operating life of the equipment under consideration is another step. The Bureau has studied the way in which reliability predictions may be affected by the choice of classifications and definitions.[2] These choices are sometimes forced by the form of available data, so that an existing data collection program may to a large extent determine the relevance and meaningfulness of a reliability prediction. On the other hand, explicit examination of alternative possibilities for classification and definition may help in designing a program for obtaining more useful subsystem and component data.

Component Reliability

In order to assess the reliability of a system, it is necessary to evaluate the reliabilities or lifetimes of the various components. Data for this purpose are provided by "life tests"—experiments in which the lifetime of a particular type of part is measured.

The Bureau has developed techniques for analyzing life test data obtained under several sets of combined environmental conditions.[3] The techniques include statistical tests of significance which evaluate the importance of environmental factors, singly or in combination, and procedures which allow confidence intervals to be calculated for the relative effect of each experimental factor on mean life. A statistical procedure was derived which gives some indication of the meaningfulness of "accelerated" life tests, that is, life tests conducted under extreme environmental conditions.

The applicability of statistical procedures for life tests, when the underlying assumptions are not satisfied, has also been investigated.[4] All statistical techniques are based on assumptions concerning the underlying probability distributions of the phenomena observed. Techniques which can be used when their special assumptions are not exactly satisfied are called "robust."

A number of widely used statistical life testing procedures are based on the assumption that the distribution of lifetime has the exponential form. The Bureau found that some of these procedures have very poor robustness. Further work on the robustness of life testing techniques is planned; it will include both theoretical studies and computer simulation of life tests.

Another type of component experiments also presents problems in theoretical statistics. This is the "aging experiment", in which life-histories of component performances, as well as length-of-life data, are collected. Work now in progress at the Bureau deals with statistical techniques that may be used for the analysis of aging experiments.

References

(1) On prediction of system performance from information on component performance, by J. R. Rosenblatt, Proc. Western Joint Computer Conference, 85 (February 1957).

(2) On prediction of system behavior, by J. R. Rosenblatt, Proc. NYU-Industry Conference on Reliability Theory, 39 (June 1958).

(3) Factorial experiments in life testing, by M. Zelen, Technometrics, 1, 269 (1959).

(4) Are life testing procedures robust? by M. Zelen and M. C. Dannemiller, Proc. Sixth National Symposium on Reliability and Quality Control in Electronics (January, 1960).

Dallas-Fort Worth Conference Now Scheduled for Oct. 10-15

The Reliability Training Conference in the Dallas-Fort Worth area has been re-scheduled for Oct. 10-15, 1960.

It had previously been scheduled for Sept. 11-17.

The course, sponsored by the ASQC Electronics Division and the PGRQC of IRE, is designed for those persons with responsibility for company reliability programs.

For additional information, see Clinics, Conferences, and Courses, page 47, this issue.

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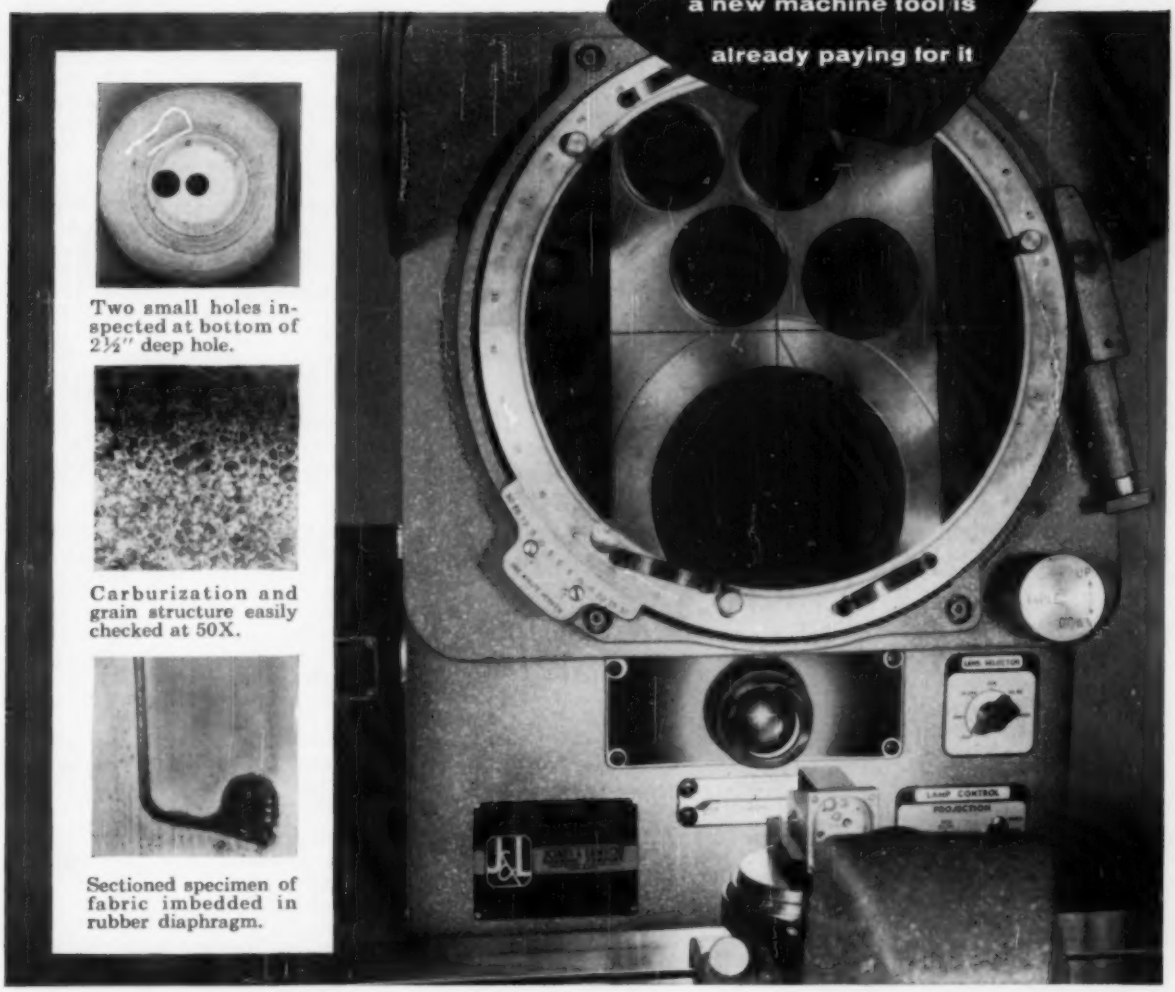

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BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

PRACTICAL PROGRAM FOR QUALITY CONTROL, by B. Frank Associates, published by National Knitted Outerwear Association, 34 pages. Reviewer: N. L. Enrick, Head, Operations Research Division, Institute of Textile Research, Charlottesville, Va.

This book approaches quality control from a viewpoint of exploring "statistical as well as other theories ... following the facts to whatever conclusions they may lead." Apparently, the conclusion was that statistical methods are of highly limited use, and indeed, it even seems that the generally accepted principles of quality control are not considered applicable to knitted garment production. For example, on page 9 we find that roving inspectors must "rove systematically ..." and that the route "is not to be at random."

The problems of selecting proper sampling plans have been simplified by the standard recommendation to "sample one bundle out of every five." In the Bibliography, there is an incomplete reference to the old 1946 edition of Grant's "Statistical Quality Control," the only quality control book selected.

ELEMENTARY MATRIX ALGEBRA, Franz E. Hohn, Macmillan Company, New York, 1958, 305 pages, $10.00. Reviewed by Dr. Ingram Olkin, Statistics Department Michigan State University, East Lansing, Michigan.

This text is designed for a course on linear transformations and matrices for juniors, seniors, and graduates whose interests lie in related fields, e.g. econometrics, engineering, statistics.

The first two chapters deal with basic definitions and operations with matrices and determinants, and leads to a discussion of the inverse of a matrix (Chapter III). Rank and equivalence, linear equations and linear dependence, are covered in Chapters IV and V. In Chapter VI, vector spaces and linear transformations are introduced, followed by a chapter on unitary and orthogonal transformations. The characteristic equation of a matrix and bilinear, quadratic and Hermitian forms are the contents of the last two chapters. There are three appendices on sum-product notation, complex numbers, and concept of isomorphism.

The reader suspects from the preface that examples from or pertaining to other fields will be given, but unfortunately, there is only a sprinkling of such. One section of particular interest to statisticians gives a discussion of Cochran's Theorem. A number of computational procedures are also given. The author has prepared a bibliography of books in other fields which involve matrix algebra.

The writing is quite lucid, and there are exercises at various levels, some direct applications of the theory, others forming an adjunct to the material covered.

The statistician is concerned with books on matrix theory which will serve either as a reference, usually of advanced material, or as prerequisite material for a course in statistics. This book falls into the latter category, and as such should be most adequate.

MANAGEMENT TECHNOLOGY — Monograph of The Institute of Management Sciences, January 1960 issue, pages 2-91, published by The Institute of Management Sciences, P. O. Box 273, Pleasantville, N. Y. Reviewed by W. D. Baten, Michigan State University, East Lansing, Mich.

Since this journal, from time to time, has articles pertaining to some of the problems relating to Quality Control it would be a good thing for those interested to examine this journal. The following is a list of articles which may be of interest to people in Quality Control:

"On Some Aspects of Technological Measurement" S. B. Littauer
"A Linear Programming Approach to Production and Employment Scheduling" Fred Hanssmann and Sidney W. Hess
"Study of a Textile Mill with the Aid of Linear Programming" Kurt Eisemann and William M. Young
"Optimization of Investment — A Solution by Linear Programming" M. E. Bertoletti, Jorge Chapiro, and Horacio R. Rieznik
"Planning Continuous Production by Linear Programming" M. E. Bertoletti
"The Demonstration of Statistical Control Problems by an Electronic Analog" John P. Hyland
"Design of a Management Information System" David S. Stoller and Richard L. Van Horn

QUALITATSKONTROLLE UND OPERATIONAL RESEARCH ("Quality Control and Operations Research), published monthly for the German Association for Quality Control (Deutsche Arbeitsgemeinschaft fur Statistische Qualitatskontrolle) and the German Association for Operational Research (Arbeitskreis Operational Research), by Rudolf Haufe Verlag, Freiburg im Breisgau, Germany, Dr. H. Woorner, editor. Reviewed by N. L. Enrick, associate director of research, Institute of Textile Technology, Charlottesville, Va.

Published originally five years ago as "Qualitatskontrolle," this journal recently added "Operational Research" to its title. The Association explains the use of the English name as necessitated by the fact that "no proper German Translation has been found, nor is it likely to be found in the near future." Articles relate to practical and theoretical aspects of quality control. In the January 1960 issue, being the first edition carrying the O. R. designation in the title, there is an operations research paper, on the means of obtaining optimum returns from raw materials input in a steel mill. The articles are of good quality and are generally supplemented with good illustrative chart and diagrams. An occasional deficiency is noted in the lack of documentation by reference to prior work on which some of the articles are based.

DYNAMIC MANAGEMENT DECISION GAMES by Jay R. Greene and Roger L. Sisson, New York, John Wiley and Sons, Inc., 1959, 84 pages, $2.95. Reviewed by Richard C. Henshaw, Jr., Michigan State University, East Lansing, Mich.

The potentialities of management games as a pedagogical tool are not being adequately exploited. This situation is a result, in part, of the extensive publicity that computer games have received in comparison to the seemingly less glamorous non-computer games.

An accurate and concise description of this book is that it is a how-to-do-it manual of non-computer games. Readers who are familiar with computers will rapidly become aware that computer scoring is not only unnecessary for many management games but in fact for some would be highly inefficient. Classification as a computer game is not apropos in general since it would be entirely possible to hand score many of the existing "computer" games.

Player instructions, instructor background information, and referee materials are provided in each of

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seven games. The order of presentation is such that the games become successively more complex.

(1) The Materials Inventory Management Game illustrates the use of the Economic Order Quantity formula in inventory control and some very simple demand forecasting.

(2) The Personnel Assignment Management Game has been designed to be solvable by the "assignment" method of linear programming; the problem is to assign a set of accounting teams to jobs to be performed.

(3) The Retailing Department Management Game confronts the participants with the day-to-day policy-making problems found in a retail store. The authors say that "numerous plays of this game have shown that there is a wide disparity between the thinking student who is well equipped with a knowledge and ability to utilize business tools and the students who makes hunch decisions and does not carefully analyze the information available" (see page 25).

(4) The Production Scheduling Management Game permits the student to schedule a small shop with three machines. A good student will arrive at the need for a Gantt Chart and should fully appreciate its value after developing it himself.

(5) The Industrial Sales Management Game requires that the student estimate market demand, develop and evaluate his sales force, offer incentives to deserving salesmen and fire those unsuited for the work, evaluate competitors' strategies, and face the cold reality of an income statement.

(6) The Top Operating Management Game educates in both policy-making and in specific tools, such as break-even analysis. It is not inaccurate to say that this game is another version (hand scored) of the first widely known business decision game, developed in 1956 for the American Management Association by C. J. Craft, Richard Bellman (a RAND mathematician), D. G. Malcolm (of Booz, Allen & Hamilton), and others.

(7) The Market Negotiation Management Game is the most elaborate. It demonstrates the interdependence of firms in a distribution chain. Manufacturers must consider the retail market and wholesalers, the raw material prices. The value of being able to borrow capital is illustrated. Pricing decisions relative to costs are an important aspect of this game.

The book contains ten chapters. The seven games briefly described above are allocated one each; the other three respectively cover the value, construction, and direction and modification, of dynamic management decision games.

I was very favorably impressed with the contents of the book. Its greatest strength is its nontechnicality, which makes it useful, as a source of information and games, for all interested persons. (Its greatest weakness from the operational gaming specialist's viewpoint is that same nontechnicality, but it seems pointless to criticize something for what it is not. For example, not a single mathematical function as such is used in any of the seven game models.) All of the relationships are represented in tables and charts so that the instructor, referees, and players do not need to use anything more advanced than arithmetic in setting up, playing, and computing the results.

It is easy to direct and modify a management game although the results will be proportional, of course, to the skill and effort expended by the instructor. The authors stress, on the other hand, that "Non-computer games are not difficult to construct" (see page 2). This is a moot point and, if true, would cast much doubt on the value of the book. It seems more likely to me that worthwhile games, like worthwhile pictures, will be created only by talented and well-trained people who are willing to expend the substantial amount of time and effort required.

INDUSTRIAL PACKAGING by W. F. Friedman and J. J. Kipnees, John Wiley & Sons, Inc., February 1960, $11.50, pages vii-536. Reviewed by John O. Younger, Container Technologist, QM Food & Container Institute for the Armed Forces, Chicago, Ill.

Reviewing *Industrial Packaging* by Messrs. Friedman and Kipnees was an enjoyable experience. Here, for the first time, is a reasonably clear and compact discussion of the various aspects of industrial packaging.

The line of demarkation between consumer packaging and industrial packaging is pointedly mentioned in the preface. The reviewer found this a most desirable policy as it sets the stage for the definite inclusion or exclusion of material to be presented. While the criteria for the lines of distinction between the two packaging fields were familiar to the reviewer, it is one, if not the most excellent of definitions possible and should be particularly useful to the student.

It was particularly pleasing to find that the material presented includes the most recent techniques, materials and innovations in packaging. Such information is needed by veteran workers in the field as well as by those just entering it. And speaking of the new recruits in packaging, particularly the newly graduated packaging technologists and engineers, it is quite possible that this book offers the best "refresher course" available. It is very easy to read, the coverage is thorough and complete, and the reference material is both pertinent and copious. The book is so compact in fact that for student purposes a second or third careful reading would probably be necessary to obtain the full impact of the contents.

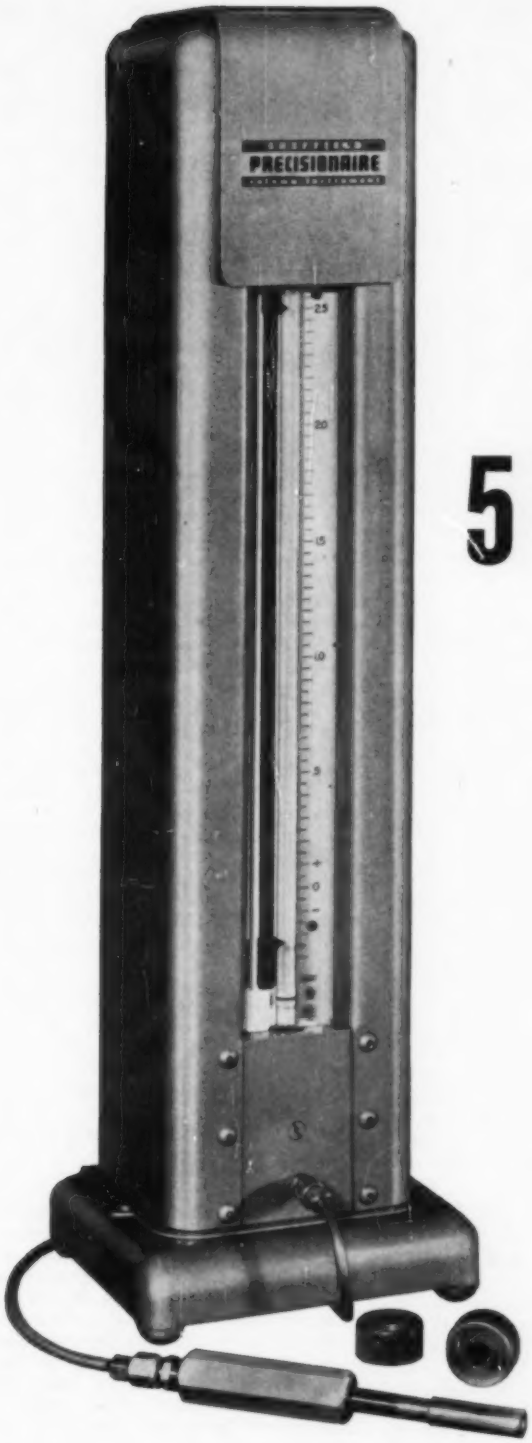
The book is not only admirably suited to use as a text, but also has great value as a handbook. The information supplied the reader might, to be sure, be available in a number of different publications, brochures, books, etc., but in this one volume we have literally a small library of packaging knowledge.

In short, to this reviewer, the scope and thoroughness of the book are most impressive. Having made this statement, I may be permitted to comment briefly on a few flaws. Thus, it is regrettable that in Chapter 7, pages 294-5 an error was made in the captions of two of the illustrations. No permanent damage is done by such a small blunder but it does take the reader a moment or two to straighten things out and get back to his reading. I also feel that additional illustrative material in describing the types of nails would have been useful.

I noted, as I read along, that the baling method of packaging was not discussed. Perhaps another reader, not connected with the Military, would not consider this omission of any importance. The military still use baling as a packaging method, however, and the method clearly falls under the heading of industrial packaging. With respect to the tie mechanism used both with bales and with textile and paper sacks, the writer feels that some slight additional data might be included, particularly on the wire tie methods now available.

Continuing with suggestions that might be put to use in some later revision of this excellent book, I believe that dividing the chapters into sub-divisions would improve the book as a classroom text. Along with this device — time-honored in college textbook format — a more detailed Table of Contents would be convenient in instruction since it would enable an instructor to specify his assignments readily and clearly.

In my view, as earlier stated, this is a compact book. It may, for some classroom purposes, be over rather than under-loaded. Fortunately, the subject index is very detailed and complete. As one who has pored over innumerable tomes in the library, I have come to have a very hearty dislike for a book without a thorough and detailed subject index.



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ROY A. WYLIE, *Editor*
Ampex Corporation

P-7-1—Coleman Instruments' new automatic nitrogen analyzer is a fully automated device for performing the time-tested micro-Dumas method for a complete determination of nitrogen content. It will measure nitrogen in a variety of materials — pharmaceuticals, foods, fabrics, fertilizers, chemicals — and it is excellent for numerous determinations presently made by the Kjeldahl process. Operation is simple — and only one operator is necessary for continuous determinations. Nitrogen is gathered in a new type of nitrometer and nitrogen volume is read directly in cc's from a digital counter. Only 18 inches of lab bench space are required for the instrument. This new instrument achieves the accuracy inherent in the micro-Dumas process, and it eliminates individual analytical technique as a factor in the analysis. The Coleman Automatic Nitrogen Analyzer is priced at $2495.00 complete.

* * *

P-7-2—The Lufkin Rule Company announces a completely new line of Dial Indicators in four series, A.G.D. Groups 1, 2, 3, and 4. They are built for longer life and are available with full jewelled or plain bearings. Shock-cushion models are also available. There are no die castings for any moving parts. The case is solid brass and the metal dials have a dull-white, non-glare background with fine graduations that are easy to read. Pivots, gears, rack and pinion are stainless steel for rust and wear resistance.

* * *

P-7-3—A stress computer for producing a textbook definition "stress-strain" curve recording has been developed for Riehle recorders. The instrument is designed to expedite the recording of information in materials testing for research and industrial control operations. Now being used to convert load to stress on Riehle Electro Balance type of universal testing machines, the device converts the load axis pen travel on the recorder to a stress value after the factors of original specimen area and approximate strength value have been introduced. It is essentially a proportioning device that alters the ratio of full scale pen travel to some fraction of the scale to plot as full scale recorder pen travel. The new stress computer is available as a factory installation only, since it is built into the electro-balanced indicating unit early in its assembly.

* * *

P-7-4—A new instrument for the non-destructive measuring of crack depths in forgings, castings, steel bars, rods, etc. has been introduced by the Iroquois Tool Supply Co. Using an alternating medium-frequency current of low intensity and voltage, the gauge measures the drop in potential against a given section of the surface. With a sound (solid surface) conductor, the loss is equal on any portion. In the presence of a crack, the drop in potential is greater and by measuring this, the depth of the crack can be immediately read off the instrument. It is adjustable to two measuring ranges, from 0-3/16 of an inch and 0-1 inch. Operation of the device is simple, and the unit is suited for routine shop service. The instrument will readily handle round and grooved work pieces, crankshafts, etc.

* * *

P-7-5—Battery operated, transistorized vacuum gauges with ranges of 0 to 1000 microns of mercury or 0-20 millimeters of mercury are now available from Hastings-Raydist, Inc. Portable or panel mounted models are available in either range. The new gages are designed for high accuracy; rapid response; direct reading; matched, interchangeable gauge tubes; ruggedized, sealed meter and spring-loaded on-off switch. They provide continuous, practically instantaneous, measurement of the pressure of a gas under vacuum. All models have an accurate ruggedized, sealed, electrical indicating meter which is calibrated directly in terms of pressure. Continuous readings may be made without affecting the pressure in the system. All models also include a spring-loaded on-off switch to prevent battery drain when the instrument is not in use. The rugged gauge tubes afford freedom from out-gassing, system contamination and corrosion. They connect to the vacuum system by means of a standard 1/8 inch NPT male pipe thread. Availability of matched and interchangeable gauge tubes allows the user to monitor at multiple gauge tube locations with one indicator, without recalibration or resetting of the instrument. The battery operated vacuum gauges are designed for applications where an a-c power supply is not readily available and are particularly well suited to LOX tank applications.

* * *

P-7-6—High accuracy black granite reference flats for precision measurements are now being made by Acme Scientific Co. Black granite is inherently non-magnetic and dimensionally stable. It will not warp even under extreme changes in temperature. An accidental scratch on the surface will not raise a burr or shoulder. Thus, flatness and accuracy are not destroyed. Lapped to an accuracy of 0.000005 inches, Acme Scientific's black granite flats are used wherever a surface of known and accurate flatness is required as a reference stage in measuring. Six inch and eight inch diameter flats are standard. Special sizes and other accuracies can be made to meet specific requirements.

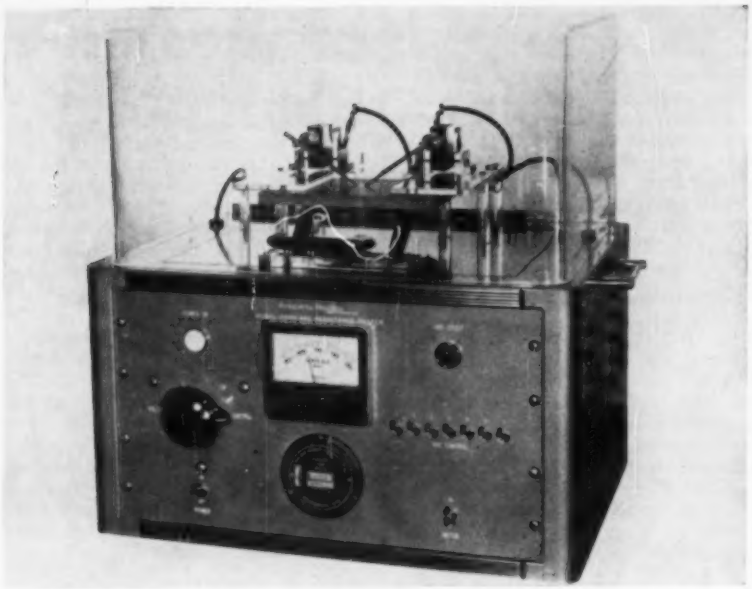
St. Louis ASQC Workshop-Seminar Oct. 6-8

The next ASQC Workshop-Seminar will be conducted Oct. 6-8, at the Statler-Hilton, St. Louis, Mo., according to Paul C. Clifford, director, professor at Montclair State College.

Workshop-Seminars have also been planned for Jan. 16-18, at the Penn-Sheraton Hotel, Pittsburgh, Pa., and for Apr. 6-8, in New York City or Newark, N. J.

Registration at each seminar is limited to 75 persons. Study materials and case studies will be sent to the registrants prior to the seminars.

Address inquiries to: Fourth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milw. 3, Wis.



P-7-8—The Model 8540 Arc Resistance Tester that has just been announced by Associated Research, Inc. is a compact bench-type instrument suited for both laboratory and production quality control applications. The instrument provides 15 kv at 60 ma a-c, for testing the ability of solid electrical insulating materials to resist the action of an arc, in accordance with ASTM Specification D-495 and Federal Specification LP 406B. Full compliance with these specifications is accomplished by providing the Model 8540 with voltage control that is continuously variable from 0 to 15,000 v, to allow presetting of the open circuit voltage at the test electrodes and for compensation of line voltage fluctuations; an internal blower for cooling and venting toxic gases away from the insulating material test specimen; voltmeter with suppressed zero to accurately meter the primary potential between the range of 90 to 130 volts; seven arc control switches to adjust the severity and cycling of the arc; an interval timer with manual reset for timing the total test application of the arc to the nearest one tenth second; transparent protective cage surrounding the insulating material test sample with safety interlock. Also provided are: a complete electrode assembly, specimen holder, and a jig for sharpening the electrodes in accordance with the mechanical requirements of the ASTM and Federal specifications.

* * *

P-7-7—A new development by Magnaflux Corporation is the convenience of magnetic particle inspection materials available in pressurized spray cans and plastic squeeze bottles. These materials can be used with any of the magnetic particle inspection or test kits already in operation. The ready-to-use Magnaflux-Magnaglo materials eliminate previous bulky containers and the problems of mixing to formula or filling application devices and reduce set-up time to inspect complex parts. The new sealed dispensers keep out dust, moisture, and other contamination during storage. The No. 14 M Fluorescent Magnaglo Bath and No. 9 BM Magnaflux Bath are offered in 12 oz. pressure spray cans. The No. 1 Gray Powder is now available in plastic squeeze-bottle dispensers, each containing one full pound of magnetic particles. Perforated top is designed for even powder dispersion with easy hand squeeze. These three basic low-cost test materials have been the most widely used in the earlier forms, and are identical in quality, sensitivity, and high visibility to supply continued full reliability inspection for cracks and similar defects.

* * *

P-7-9—Servo-Tek has announced a versatile package that provides speed indication for almost anything that rotates. The Servo-Tek Speed Indicating System combines the company's widely used d-c tachometer generator with an accurate 4½ inch panel-mounted meter to give full-scale speed indications ranging from 100 to as high as 12,000 rpm. The generator and indicator are connected by a low voltage cable that can be as long as 500 feet without affecting the system accuracy. Use of a permanent magnet generator eliminates the need for batteries, external power, or periodic calibration. Price of the Speed Indicating System is $87.00.

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P-7-10—Branson Ultrasonic Corporation has introduced a fully transistorized, self-contained, ultrasonic cleaning unit. The Model LGT-40 is designed for cleaning precision parts, electronic components, investment castings, jewelry, bearings, small sub-assemblies, dies, molds, spinnerets, or instruments from which a variety of soil and contaminants must be removed. The unit takes advantage of the latest advances in semi-conductors to achieve a powerful, rugged, compact arrangement for long life with little or no maintenance. The design is simple, an on-off switch being the only generator control required. A second switch controls an integral heating element to keep the cleaning solution at the proper temperature. Both housing and inner tank are of 300-series stainless steel. The generator output is 40 watt, average, 80 watts on peak. Power input is 120 watts at 115 volts, 50/60 cycle a-c. The unit is 14 inches deep, 7 inches wide and 13 inches at its highest point. The working area is 10 inches above the table. The model LGT-40 may be ordered either with or without an integral heater.

New Literature Available

L-7-1—Bulletin CRS-60 describes the Kentrall line of four new motorized hardness testers. By removing major test loads automatically, these new motorized hardness testers increase reproducibility of test results and raise the productive capacity of the machine. The cost of these motorized testers is the same as hand-operated machines. They are available in combination testers which provide both regular and superficial Rockwell Hardness testing in a single machine, or as single purpose instruments for either regular or superficial testing alone.

* * *

L-7-2—Bulletin No. 50 describes the Comtorplug Expanding Plug Gage equipped for "between pins" gaging of internal splines and gears. Essentially, the internal spline gage is an adaptation of a standard Comtor Expansion Plug fitted for spline gaging by mounting gear wires thereon so that all the paraphernalia otherwise required for making between-pins or over-pins measurement is contained in a single package.

* * *

L-7-3—A brochure describing the Model 137-G Grating "Infracord" infrared spectrophotometer, a new low-cost instrument which makes possible for the first time high resolution runs in the significant near-infrared wavelength region between 0.83μ and 7.65μ, has been published by the Instrument Division, Perkin-Elmer Corp.

* * *

L-7-4—Instruments for laboratory analysis, process quality control and research are described in a new 16 page general catalog published by the Analytical and Control Division of Consolidated Electrodynamics Corp. Described are techniques and instruments for leak detection, mass spectrometry, chromatography, moisture monitoring, and other types of analysis and control.

* * *

L-7-5—A 1960 guide to NEMA Standards Publications has been published and now is available from the National Electrical Manufacturers Association. The latest 18-page booklet contains descriptions of all existing NEMA Standards Publications which cover a wide range of electrical manufacturing equipment. Included are brief descriptions of twenty new books produced last year. Titles of some of these publications, all of which deal with equipment never before covered by NEMA Standards, are: Absorption Equipment, Bituminized-Fibre Conduits and Fittings, Compression-Type Pressure Connectors, Screw-Type Pressure Connectors, Quick Connect Terminals, Installation of Hydraulic-Turbine-Driven Generators, Electric House Heating Equipment, High Temperature Properties of Industrial Laminates, Electrochemical Processing Equipments, Piping Systems for Steam Turbine Generator Units, Glass-Fiber-covered Silicone-Treated Rectangular and Square Magnet Wire, Round Magnet Wire-Polyurethane-Coated, Vinyl Acetal Nylon-Coated, and Vinyl Acetal Self-Bonding and Returnable Reel Dimensions for Wires and Cables.

* * *

L-7-6—A two-page Data Sheet describes Leeds & Northrup Company's new 8692 Single Range and the 8693 Double-Range Portable Temperature Potentiometers and their advantages for making accurate temperature or millivolt measurements.

* * *

L-7-7—A new four-page bulletin on its low-cost V64 digital voltmeter is being offered by Non-Linear Systems, Inc. The folder compares the full four-digit V64 with pointer meters and three-digit voltmeters in price and usefulness.

THE FIVE YEAR INDEX

to

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Variations of Mechanical Properties in Aluminum Products

Air Force Quality Control 1960-1962
Army Progress in Quality Control for 1959
Navy Progress in Quality Control for 1959

Integrated SQC in Food Processing

Some Statistical Concepts Applied to the Navy Calibration Program

Higher Quality—Through—People in Quality—Quality in People

An Approach to a Reliability Prediction Program

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Life Test—Some Practical Considerations

Good Enough—Isn't Good Enough

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Quality Control Programs Should Be Cost Reduction Programs

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section briefs

ALBANY . . . On Apr. 14, during the afternoon session, M. M. Jordan, Central Scientific Co., Cambridge, Mass., exhibited and explained scientific laboratory equipment. Of particular interest was the spectrometers and vapor phase chrome photo equipment.

After dinner, R. I. Tenney, Fleischmann Malting Co., gave a very interesting and informative talk. He described the correlation techniques used to predict plant performance from laboratory tests and the prediction of shelf age at which a perishable product, beer, would be rejected by the customer.

ALBUQUERQUE . . . The meeting Apr. 11, was held at the East Central branch of the Albuquerque National Bank. Section officers elected for the 1960-61 season are, chairman—J. C. Gaskins, American Car and Foundry; vice chairman—G. O. Hawley, Sandia Corp.; secretary—T. D. Harrison, Sandia Corp., and treasurer—W. H. Robertson, Sandia Corp.

The guest speaker, J. Y. McClure, QC manager, Convair Division of the General Dynamics Corp., Fort Worth, Tex., presented a talk on "Vendor QC Evaluation Program." Mr. McClure's interesting talk was illustrated by color slides and considered the salient features of the Convair evaluation program.

ALLENTOWN-BETHLEHEM . . . A. T. McPherson, National Bureau of Standards, Washington, D. C., spoke at the April meeting. Mr. McPherson chose as his topic "Standards—Good and Bad." It was a privilege to have Mr. McPherson with us!

Section chairman Ken Stephens discussed "Narrow Limit Gaging," at our pre-meeting clinic.

Our May meeting was a dinner meeting in the Hotel Traylor. This was one of our local participation nights and featured two speakers. The first was Alex M. Hanfmann, who spoke on "Quality Control by Eye." The second speaker, Charles H. Pratt, discussed "Quality Control of Wollastonite." Both speakers did commendable jobs and the section is deeply indebted to them for having taken the time and effort to work out the details of their talks.

BALTIMORE . . . On Apr. 19, a joint dinner meeting was held with the AIChE at the Engineers' Club. A large turnout was on hand to hear J. Stuart Hunter discuss the "Dynamic Impact of Statistics on Chemical Engineering."

On Apr. 6, the executive committee met at the Johns Hopkins Club. H. Ellner, our new program chairman, reported satisfactory progress in the development of the 1960-61 program. Nine meetings are being scheduled. Bill MacCrehan reported that plans for the 1960 Middle Atlantic Conference, to be held in Baltimore, Md., Nov. 11, 12, are well underway and nearing completion. The various operating committees have been formed and a skeleton of the conference program has been prepared.

BATTLE CREEK-KALAMAZOO . . . Wm. Golomski presented a very fine and understandable program on "Operations Research," at the meeting Apr. 21. Using these techniques, money can be saved even on the lowly "hot dog." Before his talk he discussed the Saddoris Award program with the executive committee.

New section officers are chairman—Arthur Dansan of Battle Creek; vice chairman—Clarence Oranje of KVP-Sutherland Paper Co.; secretary—Ralph Anderson of Engineering Castings, and treasurer—George Vaught, Goodyear Tire and Rubber Co. Junior past chairman is George Church, Fuller Manufacturing Co.

BOSTON . . . The annual Ladies' Night was celebrated on Apr. 14, at the MIT Faculty Club lounge. About 150 persons enjoyed the dinner and the illustrated "Keyhole Journey, a Look at the Communist World," by Carl De Suze, the well known radio and television personality.

The 1959-60 season closed with Len Seder presenting his paper on "Management Evaluates Its QC Needs." This was the final link to be forged in the chain of total quality control.

CHICAGO . . . An excellent program plus the much welcomed spring weather gave the Chicago section a fine turnout for the Apr. 20 general meeting.

The afternoon session was presented by Nick Orzeck, Jr., Victor Manufacturing and Gasket Co., whose topic was "Getting Optimum Use from Inspection Reports," and William Rawland, Advanced Transformer Co., who spoke on "Inspection and QC of Precision Wound Coils."

John Henry, department of mechanical engineering, University of Illinois, spoke on "Measurement and Instrument Evaluation—A Challenge," at the evening session. The topic was especially interesting to those who work with measuring instruments.

Mr. Henry is well known to the Chicago section and has been a firm believer, user and teacher of QC and its concepts since the early forties.

There will be no scheduled meetings during the months of July and August. Election of officers and the planning of the 1960-61 season will occupy the summer months. Vacations, too!

CINCINNATI . . . The section was fortunate to have J. Y. McClure, QC manager, Convair Division of the General Dynamics Corp., Fort Worth, Tex., as the speaker for the Apr. 20 technical meeting. Mr. McClure's subject was "Vendor QC Evaluation Program." An interesting question and answer session followed the presentation.

Stewart Bailey, sales engineer, Westinghouse Electrical Apparatus, provided a most interesting film on "New Developments in Electrical Research," as the coffee talk presentation.

On Apr. 17, the Cincinnati section joined with the Hamilton-Middletown section for a tour of the Food Processing Division of the Kroger Co. This interesting tour was arranged by Bob Johnson, chairman elect of the Cincinnati section.

COLUMBUS . . . The section held the annual Management Dinner Meeting Apr. 20, at the Southern Hotel. A large turnout of members and guests heard Robert Pelkey speak on "Feedback—Key to Quality Objectives."

Mr. Pelkey, supervisor of programs and controls, Ford Motor Co., outlined Ford's methods of utilizing field information to develop quality standards.

The members and guests enjoyed the question and answer period that developed at the conclusion of the meeting.

CUMBERLAND . . . "The Quality Control Man and Public Relations," was the topic of our dinner meeting Apr. 14 at the Shrine Country Club. The subject was thoroughly and skillfully explored by Bernia B. Lucas, supervisor of labor relations at the Celanese Fiber Company Amcelle plant.

Our chairman, Earl S. McColley, is on a special assignment at the Ocotlan plant of Celanese Mexicana. In return, the members of the Cumberland section were happy to be hosts to Ernesto Linares of the

Mexico City section, who has recently been promoted to the position of quality control superintendent at Ocotlan.

We all want to express our pride and pleasure on learning that a former member of our group, Paul M. Felker, Jr., has been appointed QC director of the William Carter Co. Congratulations, Paul; we're not surprised.

DALLAS-FORT WORTH . . . The Texas sections made good headway toward making a Texan of Frank Caplan, Jr., this week. This was his first visit to Texas, but we caught him saying "you-all." He spoke on "Process Control in a Job Shop." After his talk, he received a barrage of questions.

H. B. Epstein has been named chief of QC engineering for the Electronics Division of Chance Vought at Dallas, Tex. He also will act as quality assurance manager and chief inspector for the division.

EVANSVILLE-OWENSBORO . . . Ken Barten, a professor at Washington University, St. Louis, Mo., presented a very interesting program on "Simulated Computer Techniques," at the joint meeting with the American Institute of Industrial Engineers in April. The dinner meeting was held at the Shrine Temple in Evansville.

GEORGIA . . . At the meeting Apr. 22, an instructive lecture-demonstration on "How Analysis of Variance Works," was presented by Tom B. Bainbridge, assistant superintendent of the acetate yarn quality and standards department, of the Tennessee Eastman Corp., Kingsport, Tenn.

C. T. Raymo, District 15 representative, spoke on section organization, the Saddoris award program, and professional development.

GREATER DETROIT . . . The Greater Detroit section held its Eighth Annual Dinner Dance on Apr. 30, at the Loyal Wing Club in Detroit. Joey Stark provided pleasant music for dancing after a different but delectable Italian style dinner.

The dinner included antipasto, tossed salad, spaghetti, roast veal, roast chicken, brown potatoes, mushrooms, rolls and butter, chicken soup, beverage and dessert of ice cream and cookies. All this food plus cocktails before dinner and drinks following the dinner was enjoyed for only twelve dollars a couple.

Co-chairmen for planning and managing this annual social affair were Messrs. Mike Ambrozy and Dill Mourer. Our hats off to them for another very fine social get-together.

GREATER MUSKEGON . . . Ell Dee Compton, research director of the Eagle Ottawa Leather Co., described how statistics can be used to develop better products by using information from routine process data at the April meeting at the Spring Lake Country Club. He illustrated his talk with charts and slides.

The section is making a concerted effort with industry to promote a better understanding of statistical techniques and their impending usefulness. Forty persons from local industries have completed a basic statistical quality control course, and 20 persons have completed an intermediate course. The section is grateful to William Poe of John Wood and Glenn Baily of American Coil Spring for their work as course instructors.

HAMILTON-MIDDLETOWN . . . On Apr. 13, this section joined the Cincinnati section during a tour of the Process Food Division of the Kroger Co., Cincinnati, Ohio. Several of the many food processes were explained to the group. Following the tour, a brief business meeting was held and the elected officers for the 1960-61 fiscal year were announced. They are chairman—DuWayne Carlson, Champion Paper and Fibre Co.; vice chairman—Joseph Mead, Fernald; secretary—W. R. Freyberg, Champion, and treasurer—Joseph Abbott, Mosler Safe Co.

During the next three months the various section committees will outline and prepare the program for the 1960-61 season.

HARRISBURG . . . On May 2, section members and their ladies or husbands were guests of the Lambert-Hudnut Co., Lititz, Pa., for a tour of the plant. It was an interesting tour for the ladies as they could observe the processing and packaging of perfumes, lipsticks, antiseptics, face powder and toiletries.

The tour was followed by a delicious dinner served to the organ melodies of Forrest Watson at the Overlook Country Club. A. H. Flohr, quality manager of the host plant, described the facilities of the plant and its processes. The Jimmy Dunn ensemble furnished the music for dancing.

April 2 was the date of the very successful Fifth District Conference at the Yorktowne Hotel in York, Pa. More than 180 ASQC members and their friends listened to such speakers as Bill MacCrehan of Bendix Radio,

Charles T. Shewell, ASQC Fellow
Author, Senior Research Specialist

Charles Trippler (Tiny) Shewell, 57, ASQC Fellow and a senior research specialist with Humble Oil and Refining Co., Baytown, Tex., died Apr. 7, in his home, after a heart attack.

Nationally known for his knowledge in the field of statistics and mathematics, he has been with Humble's Baytown laboratories since 1925.

Mr. Shewell

Because of his work in statistics, Gov. Price Daniel last year made him honorary admiral in the Texas Navy.

He had at one time been district commissioner of the Sam Houston Area Council of Boy Scouts.

Mr. Shewell's book, "Simple Statistics for Everyday Use," has been used extensively as a text in colleges and universities in the Southwest.

He had taught several industrial courses at the University of Houston, and had served as a discussion leader at the Gordon Research Conferences. He was a productive author, and spoke often at local and national technical society meetings; several presentations had been scheduled for this summer.

In ASQC, Mr. Shewell was a member of the current council of, and publications chairman for the Chemical Division. He was the 1957-59 District 14 director, and that district's representative the preceding year. During 1958-59, he was a member of the Management-Night program committee and of the Special Awards Fund committee. He was also a member of the American Statistical Assn.

Mr. Shewell is survived by his widow, a daughter, Mrs. George Hubbard of San Jose, Calif., and a son, Dr. J. R. Shewell, who heads the physics department at Sophie Newcomb College of Tulane University.

Mason E. Wescott of Rutgers · The State University, New Brunswick, N. J.; Dorian Shainin of Rath and Strong, and Ervin Taylor of the Martin Co.

A humorous, timely skit was presented at the noon luncheon by Miss Bessie Day and F. J. Del Priore of the U. S. Navy Dept.

A coffee break was enjoyed between the morning sessions. This treat was supplied by the following companies from the host area: AMP, Harrisburg; Alcoa, Lancaster; Borg-Warner, York; Caterpillar Tractor Co., York; P. H. Gladfelter Paper Co., Spring Grove; Sylvania, York, and Raybestos-Manhattan, Manheim.

HUNTSVILLE . . . P. B. Crosby, Martin-Orlando Co., spoke on "Development of a Quality Control Program for a Multi-Project Operation," at the meeting Mar. 24. The lecture was especially interesting and timely as many of the section members are employed at Redstone Arsenal and have contact with the various phases of the quality program on the Pershing Missiles which are being built at the Martin-Orlando plant. Mr. Crosby, an ASQC member, is quality manager for ground support equipment on the Pershing Project.

INDIANAPOLIS . . . Lawrence E. Drum, manager of the Indianapolis Truck Engine Works of the International Harvester Co., served both as speaker and host for a plant tour of the Truck Engine Plant and the Gray Iron Foundry. Mr. Drum presented a very forceful and informative message on "Teamwork."

Sincere thanks of the section membership goes to the International Harvester Co., and to F. A. Bucksot, program chairman.

STATE UNIVERSITY OF IOWA . . . On April 29, an evening meeting was held at the Le Claire Hotel, Moline, Ill., by members of the State University of Iowa section, Quad City group sponsors. R. W. Hanna of the Hanna Engineering Co., Rockford, Ill., spoke on "Overlapping Tolerances—Their Use in Improving Quality."

Thirty-two persons present for the talk included both ASQC members and design engineers. Mr. Hanna was assisted by Jack Myers, Farmall Co., who used visual aids in demonstrating the effect of overlapping tolerances.

The section held a two day meeting Mar. 24, 25. It was opened with a plant tour of ALCOA, Riverdale, Ia. This tour illustrated the working of aluminum from the raw pig metal to finished sheets and coils. This was followed by a tour discussion and question and answer periods.

J. N. Berrettoni, Western Reserve University, Cleveland, Ohio, gave a very fine talk on "Variable Sampling Plans and Their Efficiency in Controlling Quality," on the morning of Mar. 25. The meeting was adjourned at 11 a.m.

JOPLIN . . . The regular monthly meeting for April was a joint meeting with ASTE. The two organizations, ASQC and ASTE co-sponsored the DoALL Company's traveling exhibit, "The Story of the Cutting Edge." The exhibit was very well presented and very well attended.

Officers for the 1960-61 season are Donald L. Lawson, chairman; R. C. Fitzgerrell, vice chairman; Art Layton, secretary, and Richard Justus, treasurer.

KANKAKEE-JOLIET . . . The section met Apr. 6 in Kankakee for a tour of operations of the Gaines Dog Food Manufacturing and packaging plant. A short business meeting was held before the tour, during which the nominating committee presented the nominations for 1960-61 officers.

LEXINGTON . . . At the April meeting of the Lexington section, members were told of the increasing uses of radioactive materials in industry. Paul McCreery, Cincinnati, head of the accountability-quality control department of the National Lead Co., Ohio, cited some of the peacetime uses of atomic energy and demonstrated, in a slide lecture, some of the methods of accurate production line measurements. The use of uranium, for instance, can be very exacting in the tracing of matter in chemical analysis and machine tool abrasion. He added that radioactive materials provide a nondestructive, continuous measurement procedure that can be controlled by unskilled employees and may involve a considerable saving in time over other laboratory procedures.

The second, or intermediate session in statistics, which was sponsored by the section and the Lafayette Vocational School, was completed Apr. 12. Thirteen persons have been awarded certificates for the successful completion of the course. John Sisto, associate mathematician, IBM, was the instructor.

LOS ANGELES . . . Election results show a resounding enthusiastic support for Jack Lancaster as 1960-61 section chairman. Mr. Lancaster is QC chief with the USAF Ballistic Missile Center, Los Angeles, Calif. Other officers are vice chairman—Bill Chapin, North American Aviation; secretary—John D. Blakely, Firestone Tire and Rubber Co., Guided Missile Division, and treasurer—Marty Saltz, Hughes Aircraft Co., re-elected for another year.

The new Inspection Group will have a chance to air its purposes over KRKD-AM, Sunday, July 3, at 6:15 p.m. Ray Primmer, founder of the group, will be interviewed by Lester Gideon, Hughes Aircraft Co., producer of the show.

Our past section chairmen were presented with special scrolls of appreciation at the May meeting. Starting with the most recent chairman, the presentations were made by the successors of each chairman.

Incidentially, the formula for getting more points in the Saddoris competition is work times contracts times more work. Such a formula is not guaranteed to win the banner, but it sure brings in the points.

LOUISVILLE . . . A dinner meeting preceded by a social hour was held Apr. 11, at Jimmy Lynn's Restaurant. At the business meeting it was announced that requests have been made for a city wide elementary QC course. This intensive course will be offered the first three weeks of May.

Congratulations to next year's section officers who are Warren Allinger, chairman; Bill Butler, vice chairman; Ray Evans, secretary, and John Bishop, treasurer.

The evening's speaker was Pem Fields from the Missile Division of Bendix Aviation, who spoke on the "Challenge of Reliability." Mr. Field's talk and pictures of missiles in production and action was most interesting and timely, especially the movie of the Navy missile Talos.

MEMPHIS . . . To round out our season of meetings concerning uses of statistics not directly associated with production, we were fortunate in hearing F. Clyde Lambert of Peat, Marwick, Mitchell Co. Mr. Lambert spoke on "Statistical Applications in Banking and Finance."

The theme of Mr. Lambert's talk involved precision counting of selected samples from a stratified inventory. This gives an accurate picture of total inventory at a much lower cost than a 100 percent count.

The meeting was held in the Memphis State University Library.

METROPOLITAN . . . On Mar. 23, an open meeting and plant tour for members, wives and guests was held at the General Motors Assembly plant in Linden, N. J. After a delightful dinner Cornelius D. Blay, plant

manager, welcomed the large group and introduced George S. Van Duyne, QC plant supervisor, who gave an interesting talk on "Quality and Reliability Control." The plant tour was very well planned and our thanks for this goes to Edmond Azar, plant personnel director.

Linear programming was the theme of our meeting Apr. 21, in New York City. Moderator for the evening was David Valinsky, City College of New York. The subjects, "Refining—Distribution Problem," and "Linear Programming Application," were very ably covered.

A pre-meeting clinic on "Linear Programming—Basic Concepts," was conducted by Mr. Valinsky.

Our May 10 meeting was held at the Hotel Robert Treat in Newark, N. J. The program was moderated by George Scheel of Sonotone Corp., and the topic was "Inspection Problems." The panel consisted of Ray Rahikka of Western Electric Co., Thomas F. Lindmar of Singer Manufacturing Co., and J. F. Vance of Alcoa. They discussed planning for inspection control and feedback, in-process and final inspection for machine control purposes, etc.

A pre-meeting clinic, "Basic Concepts of Acceptance Sampling," was conducted by W. Frey of Bristol Myers Products Division.

MID HUDSON . . . A. C. Rosander, chief of sampling and estimating methods section of the Internal Revenue Service, Washington, D.C., spoke to the section on Apr. 5. He discussed the application of work sampling techniques as a guide in determining budget and personnel requirements in an office. This was a joint meeting, with ASQC playing host to the Society for the Advancement of Management. Since this was just before tax season, Mr. Rosander had to answer questions that were not related to his speech.

MILWAUKEE . . . The section's annual Management Night was obviously a success as attested to by the 75 members and guests who threw questions at the Management panel. Sitting on the panel were Roger Wallace, works manager of the Milwaukee and McMinnville plants of the John Oster Manufacturing Co.; R. Lynn Terry, general operations manager of Oscar Mayer and Company and Robert L. Wolff, vice president, engineering, of the Centralab Division of Globe-Union, Inc. The panel members minced no words in telling their audience what their personal feelings were on the subject, "What Does Quality Control Mean to Management?"

Prior to the combination meeting-buffet supper, John Melchoir, education and training chairman of the Milwaukee section, presented a summary of the year's training sessions.

MONTREAL . . . An all-day Forum was held by the Ottawa sub-section on Saturday, Mar. 26. Four local section members were in attendance as speakers. They were Robert Cardno, F. Clow, R. Lessard, and Vance Ward.

A successful plant tour was held Mar. 30, at the Canadian Pratt and Whitney Manufacturing Plant. Approximately 40 members saw extensive inspection, test and quality control facilities. A jet engine mock-up illustrated clearly the company's product.

On Apr. 20, the monthly meeting was addressed by Edwin C. Harrington, Jr., of the Monsanto Chemical Co., Springfield, Mass. His subject, "Sequential Experimentation," explained how sequential tests are used in surface response techniques. The section expresses its appreciation to Mr. Harrington for replacing Mr. C. T. Shewell who passed away suddenly after a heart attack April 7.

The May meeting was addressed by F. A. Gnaedinger of Canadian Celanese Ltd., Drummondville, Quebec. His talk was "Paper, Pencil and Prophets."

Newly elected officers for the Northeastern Indiana section are, from the left, Ellis B. Cash, QC inspector for the Office of Inspection of Naval Material, chairman; Howard F. Spicer, QC specialist, General Electric Co., Fort Wayne, Ind., vice chairman; and Richard Smith, QC manager, North American Van Lines, secretary, Arnold Berning, QC supervisor, General Electric Co., Decatur, Ill., newly elected treasurer, was not present for the photograph.

NORTHEAST TENNESSEE . . . After postponement because of bad weather, the section's twelfth general membership meeting was finally held Mar. 22 at the John Sevier Hotel in Johnson City. Panel discussions on "Sampling" and "Statistical Methods" were held beginning at 6:30 p.m.

The discussions were followed by dinner and a presentation by V. S. Doehr, department head, quality control supplier liaison department, Chrysler Corp., Missile Division. Mr. Doehr's subject was "Source Inspection as a Quality Control Tool." In addition to his talk on vendor and subcontractor quality, Mr. Doehr showed two interesting films. The first was entitled "Road to the Stars," and the second was "Ground Support Equipment for Missiles."

The thirteenth general membership meeting was held April 12 at the Tennessee Eastman Co. Panel discussions on "Calculations of Standard Deviation," were held at 6:30 p.m., with Stanley Murray acting as moderator. Dinner was served in the cafeteria and a business meeting followed. Officers for the coming year were elected.

Following the business meeting, J. A. Davies, manager, statistical engineering section, Receiving Tube Department, General Electric Co., Owensboro Tube plant, gave a presentation on "Variables Sampling Without Calculations." Mr. Davies' presentation covered the methods for making quick calculations to determine special limits and ranges for the control of a process.

NORTHEASTERN INDIANA . . . Harry T. Burgess, director of product reliability for the New Departure Division, GMC, Bristol, Conn., spoke at the meeting April 21. His topic was "Reliability—Today's Challenge." Mr. Burgess has more than 30 years experience in the field of ball bearings; much of it in the field of quality control. In his position as director of product reliability, he concerns himself with every phase of New Departure operations—from research and development through to final installation in customer equipment. With his comprehensive quality background, Mr. Burgess was able to answer many questions raised by members after his talk. He presented everyone with a real quality challenge.

OMAHA-LINCOLN . . . The section met April 11, at the Town and Country Restaurant for a dinner meeting. G. M. Puthoff of Bendix Aviation Corp., spoke on the use of demerit ratings in the application of statistical quality control.

ORANGE . . . This recently formed section has now grown to a total membership of more than 120 persons. At the April meeting, Glenn Owen, quality control administrator for Convair, Fort Worth, Tex., discussed the entire B-58 reliability program. This covered organization, prediction, data processing and reliability measurement, along with some of the difficulties they had experienced.

The election results were announced, with S. Sy Bushler accepting the position of chairman, Bill Hurst re-elected as vice chairman, and Paul Charron re-elected as treasurer.

Harry Romig discussed rotating and reliability at the May meeting. His talk covered the design, material and personnel aspects as they affect the reliability of the product.

The clinic sessons, which are in full swing, cover basic QC. These are being programmed by Carl Boswell, who is noted for his complete knowledge of the subject, both from a technical as well as a psychological standpoint.

PARKERSBURG . . . A joint meeting with the AIChE was held April 18, at the Stratford Hotel in Parkersburg, W. Va. Charles R. Hicks, associate professor at Purdue University, spoke on "Statistical Thinking for the Engineer."

Ladies' Night, our annual Dinner Meeting, was held May 11, at the Chancellor Hotel in Parkersburg, W. Va. A. C. Rosander, chief of sampling and estimating methods section of the Internal Revenue Service, Washington, D. C., spoke on "Probability and Statistics in Tax Operations." New officers were also installed for the coming year.

PENSACOLA-MOBILE . . . Fred Seguin, our section secretary, was the guest speaker at the April 19 meeting in Pensacola, Fla. We were all very proud, as one of our own members presented one of the finest talks of the season. On the subject of "Paperwork Quality Control," Mr. Seguin pointed out how a small error on an Air Force requisition document could result in the wrong material being shipped to the wrong location in quantities either too large or tool small. The talk was supplemented with many yards of flow process charts, presented specifically to impress the audience with the complexity of document routing in an organization as large as the Air Force. Many attending members were seen leaving the meeting with that far-away look, indicative that they were thinking of all possible applications of a program similar to the one presented.

PHILADELPHIA . . . Section activities for April were more active than usual. On April 9, we had a very successful Workshop Clinic at the Philadelphia Textile Institute and on the 21st the section visited the modern facilities of Smith, Klein and French Laboratories.

The Workshop Clinic which was probably a preview of a similar type program for the 1961 Convention, had a tool show flavor with actual gages and measuring instruments on hand to handle and observe in operation. Lectures by David Pollock of Standard Gage Co.; Robert Schofield of Airborne Instruments Laboratory, and David Kirk of Moore Products Co.; supplied the theories and technical background on the mechanical, electronic and pneumatic gages on display. Our thanks to Adolph Mall, education committee chairman, for arranging the program.

The guided tour through the production and research departments of S. K. F. Laboratories was very interesting regardless of a member's particular interest in QC. To production minded people, the pill manufacturing and packaging processes were the highlight. To those interested in R & D the facilities and manpower devoted to developing pharmaceuticals was most impressive. After

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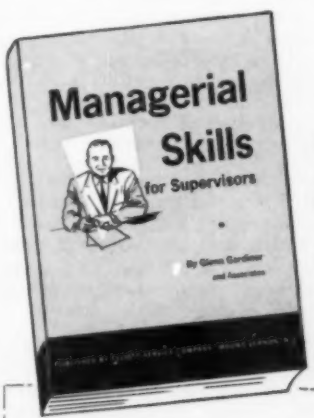

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Jules Mehalek at the rostrum opens the program for the Workshop Clinic, which was held in April at the Philadelphia Textile Institute. Guest speakers are in the background.

the tour, the section assembled at McCallisters for dinner and had the pleasure of hearing the energetic young vice president, Thomas M. Rauch, speak on "Prescription for Tomorrow."

PHOENIX . . . The April meeting was the second Ladies' Night of the season. It was held at the Casa Vieja. The new officers for the coming year were introduced. They are chairman—William Wagner, Air Research Manufacturing Co.; vice chairman—Engene Kirsch, General Electric Co.; secretary—Charles Score, Arizona Air Procurement District, USAF, and treasurer—Julius Abdai, Sperry Phoenix Co.

The meeting was highlighted for the ladies in an unusual manner as far as QC was concerned. Mrs. Kay Elder, nationally known fashion coordinator and designer, gave a very fascinating and highly informative lecture on the subject of fashion.

SACRAMENTO . . . Our monthly meeting was held April 19, at Parisi's Restaurant. Bruno Felice, manager of research and QC, Felice & Perrelli, Richmond, Calif., spoke on "QC in the Canning Industry."

Mr. Felice has been instrumental in establishing statistical QC techniques in about 10 percent of the canning industries. He discussed the application of simplified QC techniques to canned peaches by control of fill weight. This approach to application of statistical QC technique was unique, due to factors of texture, sweetness, ripeness, and team effort by the operators.

SEATTLE . . . At the April meeting, Richard J. Mullikin, assistant regional director, Bureau of Census, Seattle, Wash., discussed the preparation for, and methods to be used in, the collection and processing of data in the 1960 census.

Nominations for the 1960-61 section officers were accepted.

ST. LOUIS . . . The annual St. Louis Conference was an unqualified success. Especially good were the six technical papers presented in two parallel lines. One line was concerned with general applications of engineering statistics and quality control techniques to industry as a whole, with subject matter ranging from the design of experiment to the creation of quality attitude in operating personnel. The other line was more specific — quality control in the paper industry. At lunch, Col. Robert E. Herndon, Jr., of the Aeronautical Chart and Information Center, discussed innovations in mapping for astronauts in orbit, and moon explorers.

New officers for the 1960-61 season are E. H. Barnett, chairman; M. N. Whitehead, vice chairman; G. S. Goodman, secretary, H. T. Bock, treasurer, and W. O. Feldmeier, E. W. Corbett and S. D. Krasner, directors.

SAN DIEGO . . . New officers for the 1960-61 term are chairman — Russ Medlock, chief of support QC, Convair-Astronautics; vice chairman — V. J. Sherkenback, chief of inspection, Solar Aircraft; secretary — S. S. Smith, general supervisor inspection, Convair-Astronautics, and treasurer — J. M. Aldrich, assistant chief inspector, Rohr Aircraft.

Program planning is underway for the coming year and judging by the approach being taken by our program committee our "coming events" will be real interesting.

Seems our happy meeting place for the past couple of years has "gone by the board" as the Lafayette Hotel has converted all meeting rooms into office areas.

The meeting last month at the Sands Hotel proved to be most interesting with a very good program being presented by F. A. Monahan, manager of manufacturing development, Convair, San Diego, Calif.

SOUTH BEND-MISHAWAKA — New officers for the 1960-61 season are chairman — Leslie C. Whitcomb, U.S. Rubber Co., Mishawaka, Ind.; vice chairman — Donald L. Correll, Dodge Manufacturing Corp., Mishawaka, Ind.; secretary — Marvin C. Carlson, McGill Manufacturing Co., Valpraiso, Ind., and treasurer — George W. Hughes, Empire Box Co., South Bend, Ind.

SOUTHERN CONNECTICUT — The section proudly announces the election, at the April 13 meeting, of the following officers for the 1960-61 season: chairman — Howard A. Rosenberg, QC manager, U. I. Division, Burndy Corp; vice chairman — Frank A. Walsh, supervisor of QC and internal inspection, Dictaphone Corp.; secretary — William C. Northup, quality engineer, U. I. Division, Burndy Corp., and treasurer — George Georgulis, chief inspector, Sorensen and Co.

At the same meeting, held at the General Electric Institute in Bridgeport, Conn., Joseph D. Allen, Jr., chief field metallurgist of the Federated Metals Division of American Smelting and Refining Co., presented an enlightening talk on "Non-Ferrous Ingot and Casting Quality."

SYRACUSE . . . A presentation and slides on QC has been prepared for in-plant use by the QC department of Electric Auto Lite Co.

The slide rule which our section contributes annually to the Science Congress for junior and high school students was won this year by Charles Cody from North Syracuse. Mr. Cody was one of the top four competitors and also won the trip sponsored by the General Electric Co., to the Schenectady plant.

TENNESSEE . . . The results of the election of section officers for 1960-61 have been announced. Congratulations are in order for our new chairman — Jack A. Riegert, vice chairman — Eric E. Johnson, secretary — Roberta L. McCutchen, and treasurer — H. Alan Lasater. We wish, also, to express our appreciation to the outgoing officers for the fine job they have done this past year.

Another successful "Something for Everyone" meeting was held April 14. Three talks were enjoyed by members and guests.

E. W. Bailey, inspection department supervisor, Union Carbide Nuclear Co., discussed "What Inspection Expects of QC" and predicted new areas in which application of QC will serve the inspection function.

Eric Johnson, statistician with the Union Carbide Nuclear Co., spoke on "Product Quality Using Tolerance Factors." During the talk, Mr. Johnson demonstrated a method of product quality certification which recognizes the uncertainties of measurements. "MIL-Q-9858 QC System Requirements," were presented by E. B. Windisch, a QC director for the Navy Department of Material Inspection. Following the discussion a social period was enjoyed.

TOLEDO . . . At the April meeting Russell Brown, director of budget control, Dana Corp., spoke on "Budgeting the Cost of Acceptable Quality." Mr. Brown found himself involved in some very penetrating questions at the conclusion of his talk. It seems everyone is interested in money.

The election results and new officers were announced at the meeting.

An officers and directors meeting was held April 18, at the E. S. T. Building to discuss plans for recruiting new members, the educational program, and to finalize plans for the May 14 social meeting at the M & S cottage at Devil's Lake. It was decided to hold inauguration of new officers and presentation of the Toulouse Award for the outstanding achievement of one section member at that time.

TORONTO . . . The 1960 Annual All Day Forum, organized by the Toronto section, was preceded by an informal get together at the Park Plaza Hotel Mar. 4, when the speakers and moderators were introduced and the Forum committee took a well deserved break and did some catching up on their social life.

There were some 440 registrants for the Forum and Banquet, an attendance which more than fulfilled expectations and assured the Forum's success. Our guest speaker at the Banquet was Mr. Ira Needles, chairman of the board, B. F. Goodrich Rubber Co., Ltd., Kitchener, Ont. He received a tremendous ovation at the conclusion of his speech, "Our Changing World."

Members and guests were treated to an inside peek at one of this continent's most modern sugar processing refineries on Mar. 23, when a plant visit was made to the Redpath Sugar Refinery, Queens Quay East, in Toronto, Ont.

A combination annual general meeting and buffet social was held April 13, at the Windsor Arms Hotel. Thirty members aided in demolishing the victuals and still had enough fight left in them afterwards to elect a new section executive.

The evening of Apr. 20, was the occasion for some 50 members and guests to visit the plant of the Continental Can Co. of Canada, Ltd., New Toronto. Each of the attendees received a cookie tin from the management as a memento of a most interesting and enjoyable tour.

Adios Amigos!

UTICA . . . On April 19, D. H. W. Allan, American Steel and Iron Institute, spoke on the development of Industry Standards by statistical methods. His wide knowledge of the QC field and his experience with the Institute combine to make a very logical approach that would satisfy the best legal minds as well as the member companies of the Institute, in the establishment of Standards for the industry.

As he has already published a few standards using this technique, he was able to furnish much information during the discussion that followed on data volume and the soundness of some of the decisions that had to be made in the compilation.

WASHINGTON, D. C. . . . The section was fortunate to procure simultaneously the time and talents of two outstanding authorities and men of experience in "Some Legal Aspects of Sampling". That was the topic of a stimulating address by H. Thomas Austern at our last meeting of the year. Mr. Austern is an attorney in Washington, an exceptionally able speaker, and a sympathetic ally of the statistician in the courts. He explained in considerable detail many of the technicalities and complications which continue to obstruct the progress of sampling surveys as legal evidence. As an assist in defeating these barriers he urged that statisticians and lawyers make an effort to better understand each other's languages, and he suggested that attendance at each other's meetings and conventions might prove a forward step toward this goal.

From his illuminating remarks we learned, for instance, that courts still prefer rule-of-thumb sampling as a basis of standards with food and drugs, and also in rate cases, although "in the field of anti-trust laws the sampling survey has made progress." He recommends *Handbook for Judges* as mandatory reading in anti-trust cases, and as a book that strongly urges acceptance of statistical surveys as evidence.

W. Edwards Deming, consultant, provided some stimulating remarks on the previous address, and bits of welcome advice in general for the statistician, citing illustrations from his personal experience. In addition, he was generous with numerous hand-outs bearing on the evening's topic.

This year's excellent programming has been rewarding in the unusually large and enthusiastic attendance by both members and guests.

WESTERN MASSACHUSETTS . . . Management Night was held at our meeting April 12, and was attended by 42 members and guests. Homer G. Perkins, secretary of Stanley Home Products, spoke on "How Management Views Quality Control." The discussion pointed out that modern industry buys quality control and leans more and more on our group for problem solving. Mr. Perkins also pointed out that QC should develop methods for evaluating its effectiveness in dollars and/or cost savings. There should be no doubt that management only buys those services which contribute to earnings.

The executive committee will meet on July 8, at the Sheraton-Kimball Hotel at 7 p.m., to firm plans for our 1960-61 season. Those in attendance will be Messrs, Carter, Baumann, Lezinski, Donnelly, Scalise, Blew, Aldrich, Edlestein, Dunphy and Laybourne.

WINNEBAGO . . . Grant Haney, Jr., QC specialist, Phillips Petroleum Co., Waco, Tex., spoke on "Sampling for Process Control vs. Acceptance Sampling," at the May meeting.

At the April meeting, W. W. Spencer, manager of process control engineering, Manufacturing Services Division, General Electric Co., N. Y., gave an interesting talk on "Total Quality Control."

WORCESTER . . . On May 19, the Worcester section held its annual Ladies' Night at the Hickory House in Worcester. Corsages were given to the ladies in attendance, and the couples enjoyed a social hour prior to the dinner.

Following the dinner, a very entertaining program was given by Wesley Reed of North Woodstock, Conn. Mr. Reed has a very interesting and unusual hobby of collecting and rebuilding antique musical instruments. Mr. Reed showed and explained the various types of early American instruments. He also used these instruments as accompaniment for singing old folk songs. The audience also participated in the singing of some of these old songs. A wonderful time was had by everyone present.

At the same meeting, the tellers committee announced the election of officers for the coming year. These new officers are Frederick K. Nash, chairman; Richard L. Mark, vice chairman; Daniel J. Burda, secretary, and Gerald F. Anderson, treasurer.

Harlan S. Radiker

It is with deepest regret that the Toledo section reports the recent death of Harlan S. Radiker, who was treasurer for the section this season, and secretary-elect for 1960-61. His loss to the Society cannot be measured.

YOUNGSTOWN . . . If at first you don't succeed, try again — that's our motto here at Youngstown and it has paid a dividend. William F. Buhl of the B. F. Goodrich Co., was scheduled for our March meeting, but the heavy snow just wouldn't agree, so we changed the month from winter to spring (April showers) and listened to "Work Sampling in the Office." Of course, we will have to find another night for that plant tour through the Pilsener Brewing Co. Mr. Buhl lived up to all expectations and gave us some good advice. The results of the election were announced and the new officers were introduced with all the fanfare that goes with an election year. Ron White of the Trumbull Lamp Division of General Electric Co., is our new chairman and we are looking forward to a great year. The educational course under the leadership of Carl Hansen of the Youngstown Sheet and Tube Co., is going great guns with 20 men in attendance — we are booming!

WINDSOR . . . For Ladies' Night, the program committee chose a special topic for this event — "Baking." The expert and personable speaker was Miss Helen Goodrow, assistant chief dietitian, Canada Bread Co., Toronto, Ont. The talk was supplemented with slides to illustrate the close control of materials, mixing, baking and inspection that must be exerted to maintain a quality product, in a competitive field.

Miss Goodrow explained to the group the basic makeup of bread, cookies, fruit cake, etc., and the part of QC in forecasting the reactions of the consumer. A panel of tasters is selected to review the baked products. This panel must have a keen sense of taste, aroma, and more important the ability to describe the difference.

These tests help to maintain a quality product and aid in the improvement of future goods. The statisticians in the group performed a thorough sampling of the baked goods, courtesy of the Canada Bread Co., Windsor, Ont.

Executive members are continuing their efforts for the All Day Forum, October, 1960.

Significant Differences

. . . Allentown-Bethlehem — The big news hereabouts is the appointment of **Bob Schin** as program chairman for the 1961 National Convention in Philadelphia. We know Bob will do his usual excellent job in this capacity!

Jim Talbert has transferred his affiliation from Price Battery, Hamburg, to U. S. Gauge, Sellersville, Pa.

. . . Battle Creek-Kalamazoo — Word has just been received that **George Vaught** has accepted a position of QC engineer with Cooper Tire in Findlay, Ohio.

. . . Boston — Significant Differences include the move of **Julius Dorfman** to industrial sales manager, Raytheon Co.; **Paul M. Felker** to QC manager, William Carter Co.; **Jerome M. Gilbey,** mathematical statistician, to Raytheon Co.; **Jerry E. Goldress,** to superintendent of the statistical QC section, Raytheon; **George H. Kay** to QC department head, National Co., and **Robert A. Sylvain,** to project engineer, Tampax, Inc.

. . . Chicago — **H. F. Sander** has been appointed to the newly created post of executive secretary of the Institute of Environmental Sciences. He leaves the position of director of standards and QC, Vapor Heating Corp., Chicago, Ill. Mr. Sander was one of the original founders of the Institute and served as its president from 1956 to 1958. He has been associated with Vapor for the past eleven and a half years.

. . . Cincinnati — Individuals who have been elected to lead the section for the 1960-61 season are chairman — **R. N. Johnson,** Kroger; vice chairman — **J. Christy,** NuTone; secretary — **R. Ferry,** General Electric Co., and treasurer — **T. Ratliff,** American Standard.

. . . Cumberland — **Thomas F. Costello** has joined Celanese Fibers Co., as senior QC engineer in the textile section of the Amcelle plant. He previously headed the QC department of Talon, Inc., Stanley, N. C.

Herbert C. Heineman has assumed a new position in charge of the analytical laboratory of Amcel Propulsion, Inc., Asheville, N. C.

John A. Schnelzer has accepted a position as superintendent of QC at the fibers plant of Canadian chemical, Ltd., of Edmonton, Alberta.

. . . Greater Detroit — **Bob Vujovich,** formerly with Chrysler Missile, has joined the Fruehauf Trailer Co., as director of QC for the seven manufacturing plants.

The appointment of **Eugene E. Logue** as technical director in charge of research and new product development of Solventol Chemical Products, Inc., has been announced by the president of the company, **Robert W. Huffman.** Mr. Logue was previously associated with Parker Rust Proof Co., Chrysler Corp., Union Carbide Chemicals and Peninsular Grinding Wheel in research and managerial capacities. He is also a member of the Engineering Society of Detroit and the American Chemical Society.

. . . Harrisburg — The section was honored by the presence of **Mr. and Mrs. Ralph Reeves,** at the annual Ladies' Night dinner-dance May 2. They were guests of **Mr. and Mrs. James Skelton.** Messrs. Skelton and Reeves are the district 5 ASQC directors.

Miles Nolte, gave the report on attendance of the section courses. The introductory course, held at Schick Inc., Lancaster, had an excellent attendance with 26 of 27 who started finishing the course. In the advanced course, which met at Dental Supply Co., York., all 17 persons who started the course completed it. The response to courses proposed for next year has been most encouraging.

Robert Donsen, Bearings Company of America, has been elected section chairman for 1960-61. **Joseph T. Fasnacht,** Hamilton Watch Co., will be the new secretary while **Herbert O. Pueschner,** Bendix, has been selected as the treasurer for the new season. Mr. Donsen has named his new chairmen for the various executive offices.

. . . Indianapolis — **Ed Oakley,** a QC supervisor at Delco Remy Division, GMC, has taken a new assignment in the Delco Remy engineering department.

. . . Lexington — Officers for the 1960-61 season are **Don Freeman,** chairman; **Glenn Padgett,** vice chairman; **Jack May,** secretary, and **Archie Dedman,** treasurer. Mr. Dedman is currently attending a course in advanced statistical QC at the Ordnance Management Engineering Training Agency, Rock Island, Ill.

. . . Milwaukee — **Larry Neuman,** senior member of the Milwaukee section, has been named QC manager of the Miller Brewing Co.

Bill Kuenzi has been promoted to control chemist supervisor at the Miller Brewing Co.

. . . Minnesota — **Robert Tuve,** past chairman of the Minnesota section, resigned as chief inspector at Honeywell's Aero Division to become quality manager at Honeywell's Boston Division. The new chief inspector is **Mike Kaminsky, Jr.,** formerly chief quality engineer at the Aero division.

Armond Stoefen, past chairman of the Minnesota section, is now QC staff assistant for Barber Coleman Co., Rockford, Ill. He resigned from Toni Co., St. Paul, Minn., where he was QC coordinator.

. . . Montreal — **Armin Schmidt,** Northern Electric, and **Peter Merchant,** Canadair, attended the advanced QC course at the University of Connecticut, April 3-15.

Officers for the 1960-61 season are chairman — **F. Clow,** QC engineering superintendent, Canadair Ltd.; vice chairman — **W. L. Wingfield,** Trans-Canada Airlines, and secretary-treasurer — **S. B. Thomas,** Northern Electric Co., Ltd.

. . . Northeast Tennessee — The section officers, their wives, and members of the board of directors held a business meeting May 1, at the Peerless Steak House in Johnson City, Tenn. All new committees were appointed and plans were made for the 1960-61 program.

Hubert M. Hill, section chairman, has been promoted to supervisor, applied mathematics, at Tennessee Eastman Co., Kingsport, Tenn. Mr. Hill supervises the group responsible for consultation services and computation assistance to all phases of plant operation.

Officers for the 1960-61 season are **J. T. Johnson,** chairman; **Bill Morgan,** chairman elect; **J. Moriarity,** secretary, and **C. Stone,** treasurer.

. . . Northeastern Indiana — At the meeting April 21, the section elected new officers for the 1960-61 season. The new officers are chairman — **Ellis B. Cash,** QC inspector, Office of the Inspector of Naval Material; vice chairman — **Howard F. Spicer,** QC specialist, G. P. M. Department of the General Electric Co.; secretary — **Richard K. Smith,** QC manager, North American Van Lines, Inc., and treasurer — **Arnold Berning,** QC supervisor, General Electric Co., Decatur, Ill.

. . . Orange — **Jim Allee** has been appointed quality assurance supervisor in charge of inspection at Hughes Semiconductor, Newport, Calif.

C. Kleppsattell has recently been appointed operations manager for XYTAN Corp., of Costa Mesa.

J. Morey has left the QC manager position at Hughes Fullerton and assumed the quality assurance manager's role at the Newport Division.

Fred Peck has taken a position on the corporate office staff for Hughes Culver City as assistant to the vice president.

W. Hurst has taken a position as vice president in charge of QC and sales for Newport Scientific Co., of Newport.

Sy Bushler has taken a position of supervisor of project engineers at Hughes Newport.

Howard Ingram has returned to the area and is now chief inspector for Nortronics Corp.

John Simm has been appointed quality assurance administrator for the systems division of Becman Insts.

E. Murachver has been advanced to a member of the technical staff at Hughes Newport, Semiconductor Div.

. . . Parkersburg — This section now has two classes in QC instruction — the advanced has 13 enrolled, the basic has 23 enrolled.

. . . Pensacola-Mobile — The section executive committee met at the Malibis Hotel Court on May 11, to make plans for the coming year's activities.

. . . Sacramento — **Paul S. Reis,** senior engineer for the Aerojet-General Corp., Sacramento, Calif., and section treasurer, has founded a TAU BETA PI alumnus chapter in Sacramento and has been elected its first president.

TAU BETA PI is the national honorary fraternity in engineering. The Sacramento chapter has grown to 84 members. Its purpose is to foster better engineering education in the greater Sacramento area.

Edwin B. Weinberg, head of the department of engineering at Sacramento State College, spoke at the last meeting on engineering education and what TAU BETA PI can do to help the program.

. . . Southern Connecticut — **Richard G. DiPaola** has been appointed QC manager of National Semiconductor Corp., Danbury, Conn. Mr. DiPaola previously supervised the Semiconductor Standards Group at Sperry Gyroscope Co., Great Neck, N. Y.

. . . Syracuse — **John E. Biegel,** professor of engineering at Syracuse University and QC Consultant, has transferred his membership from the Albuquerque to the Syracuse section.

Robert M. Hofstead, Bristol Laboratories, spoke on "The Realization of Anti-biotics," at a meeting of the Southern Tier Technical Society in Binghamton.

George A. Endrich, General Electric Co., moderated a session on "Fundamentals of Linear Programming," at the One Day Conference, April 30, sponsored by the Corning-Elmira and Binghamton sections.

. . . Tennessee — **Dave Chambers** recently gave a talk at the 12th Annual Convention of the Southeastern Section, American Accounting Society.

. . . Utica — New officers for the 1960-61 season are chairman — **Howard L. Berke,** General Electric Co.; vice chairman — **Samuel L. Roberts,** General Electric Co.; secretary — **Richard McLoughlin,** Radio Corporation of America, and treasurer — **Richard B. McCreary,** General Electric Co.

. . . Western Massachusetts — The Connecticut Valley Technical Societies, the Western Massachusetts Purchasing Agents and the Holyoke Industrial Association have been very helpful this season in sponsoring joint meetings, clinics and supporting our educational program. Truly the Society has been a service to industry in our area.

. . . Windsor — **Jim McMillan** and **Isley Reid** are in Australia with Ford Motor to assist in a re-tooling program.

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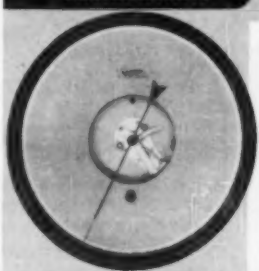

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EVOP Course Scheduled for Houston

An Evolutionary Operations (EVOP) course will be held Sept. 30 and Oct. 1, at the Ben Milam Hotel, Houston, Tex. The course will be sponsored by the ASQC Chemical Division and the South Texas section.

Instructors will be J. Stuart Hunter, University of Wisconsin, and Truman L. Koehler, American Cyanamid Co. The course fee is $100.00. Registration will be limited to 50 persons.

This is the first time that an EVOP course has been offered in this section of the country. Interested persons should register as soon as possible. Contact Jim C. Deland, registration chairman, Shell Oil Co., P. O. Box 2527, Houston 1, Tex.

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QUALITY MANAGER, Age 35, five years experience quality control in semiconductor and light manufacturing. Five years supervision quality control and inspection in manufacturing of controls. Registered engineer. Teaching experience. Reply Box 17A3.

SUPERVISOR OF QUALITY CONTROL. B.Ch.E. Graduate study S.Q.C. Age 31. Six years quality control experience. Head of quality control department plastics plant. Reply to Box 17A2.

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. . **25-Aug. 5**—Courses in Programming and Artificial Intelligence and Introduction to the Use of Digital Computers, contact James G. Steagall, University of North Carolina, Extension Division, Box 1050, Chapel Hill, N. C.

AUGUST

. . . **1-19**—1960 Statistical Methods in Industry Course, University of California, Los Angeles campus, five major courses are QC by statistical methods; industrial statistical methods; design and analysis of industrial experiments, industrial reliability, and basic measurements and standards. Participants will have a choice of seven seminar or special laboratory groups and a general lecture series. Instructors include I. W. Burr, Charles Hicks, L. A. Knowler and Robert C. McMaster, contact Edward P. Coleman, Department of Engineering, University of California, Los Angeles 24, Calif.

. . . **7-19**—Third Annual Institute on Missile Technology at the Continuing Education Center, Storrs, Conn., sponsored by the Army Research Office, Office of the Chief of Research and Development—U. S. Army. Session Aug. 13: "Reliability Improvement & Control," by Dorian Shainin. Fee—$325. Contact Albert L. Jeffers, Box U-56, The University of Connecticut, Storrs, Conn.

. . . **8-19**—Ninth Pulp and Paper Statistics Course, Brevard College, Brevard, N. C. Fee for either the basic or advanced section of the course is $275, covering room and board for the two-week period, textbook, and other materials. Both courses will be held concurrently. Contact R. J. Hader, The Institute of Statistics, North Carolina State College, Raleigh, N. C.

. . . **15-25**—Thirteenth Annual Intensive Course in Quality Control by Statistical Methods, a first course for executives and supervisory personnel, practical and mathematically nontechnical, instructors will be Fred Beeler, Western Michigan University; C. C. Craig, University of Michigan; E. G. Olds, Carnegie Institute of Technology, and Mason E. Wescott, Rutgers University; contact C. C. Craig, course director, 106 Rackham Bldg., Ann Arbor, Mich.

. . . **22-24**—Fourteenth Alkaline Pulping Conference at the Multnomah Hotel, Portland, Oregon, one of 10 functional conferences for 1960 sponsored by the Technical Association of the Pulp and Paper Industry. Pre-register before Aug. 1. Contact H. O. Teeple, TAPPI, 360 Lexington Ave., New York 17, N. Y.

. . . **24-27**—Forest Biology Conference at the New Washington Hotel, Seattle, Wash., sponsored by the Technical Association of the Pulp and Paper Industry. This Conference will be followed by the World Forestry Conference at the University of Washington, Seattle, Wash. Pre-register before July 15. Contact TAPPI, 360 Lexington Ave., New York 17, N. Y.

. . . **29-Sept. 5**—The American Mathematical Society will hold its annual Summer Meeting at Michigan State University, East Lansing, Mich., in conjunction with the Mathematical Association of America and the Society for Industrial and Applied Mathematics. Contact the American Mathematical Society, 190 Hope St., Providence 6, R. I.

SEPTEMBER

. . . **1-3**—European Organization for Quality Control Conference, "Controlling Product Quality—Its Value to Industry," Church House, London, contact British Productivity Council (EOQC 1960 Conference), 21, Tothill St., London, S. W. I., England.

. . . **10—Fifteenth Annual Forum, sponsored by the ASQC Greater Detroit section at the Rackham Bldg., University of Michigan, Ann Arbor, Mich. This is a one day forum of unusual and basic QC techniques. Contact Jack Diggs, 31783 Scone, Livonia, Mich.**

. . . **10—Rutger's Quality Control Conference at Rutgers • The State University, New Brunswick, N. J., contact Wm. F. Frey, Bristol Laboratories, Elmsford N. Y.**

. . . **26-30**—Instrument Society of America Fall Instrument-Automation Conference and Exhibit and 15th Annual Meeting, New York Coliseum, New York, N. Y., contact Director of Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **27-29**—Eleventh Annual Testing Conference sponsored by the Technical Association of the Pulp and Paper Industry (TAPPI), Pantlind Hotel, Grand Rapids, Mich. A symposium will be conducted on the testing of "Water—the Most Important Non-Fibrous Raw Material." Contact TAPPI, 11th Testing Conference, Pantlind Hotel, Grand Rapids, Mich.

. . . **30-Oct. 1—Evolutionary Operations (EVOP) Course sponsored jointly by the ASQC Chemical Division and the ASQC South Texas section at the Ben Milam Hotel Houston, Tex. Instructors will be J. Stuart Hunter, University of Wisconsin, and Truman L. Koehler, American Cyanamid Co. Course fee is $100.00, and registration will be limited to 50 persons. Contact Jim C. Deland, Shell Oil Co., P. O. Box 2527, Houston 1, Tex.**

OCTOBER

. . . **4-7**—Tenth Annual Instrument Symposium and Research Equipment Exhibit, National Institutes of Health, Bethesda, Md., sponsored by the Washington sections of the American Association of Clinical Chemists, American Chemical Society, Instrument Society of America, Society of American Bacteriologists, Society for Experimental Biology and Medicine; primary topics include fluorescence, infra-red, activation analysis, ultra-centrifuge, microscopy and electrodes. Contact Herman C. Ellinghausen, Agricultural Research Center, U. S. Department of Agriculture, Beltsville, Md.

. . . **6-8—Fourth ASQC Workshop - Seminar, Statler Hilton Hotel, St. Louis, Mo., Paul C. Clifford, director, professor at Montclair State College. Address inquiries to: Fourth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milw. 3, Wis.**

. . . **10-15—Reliability Training Conference at the Lake Texhoma Lodge near Kingston, Okla., north of the Dallas-Fort Worth area, sponsored by the ASQC Electronics Division and the PGRQC of IRE, contact Art Roddey, registration chairman, Institute for Defense Analysis, The Pentagon, Washington 25, D. C.**

. . . **14-15—Fifteenth Midwest Quality Control Conference, Wichita, Kans., contact Ralph D. Humphries, Cessna Aircraft, Wichita, Kans.**

. . . **19-21—Fourteenth New England Quality Control Conference, Hotel Bancroft, Worcester, Mass., contact Francis B. Olson, Norton Company, New Bond St., Worcester, Mass.**

. . . **20-22**—Seventh International Meeting, Institute of Management Sciences, for administrators and scientists in the field of management, Hotel Roosevelt, New York, N. Y. Registration fees—members $15, non-members $20, students $5. Contact James Townsend, 30 East 42nd St., New York 17, N. Y.

. . . **23-27**—15th Engineering Conference, Robert Meyer Hotel, Jacksonville, Fla., sponsored by the Technical Association of the Pulp and Paper Industry (TAPPI), contact Eleanor Ney Wark, Technical Association of the Pulp and Paper Industry, 360 Lexington Ave., New York 17, N. Y.

NOVEMBER

. . . **15-16**—Symposium on Engineering Applications of Probability and Random Function Theory, Lafayette, Ind., sponsored by Purdue University. The symposium will stress applications of probability and random function theory Contact J. L. Bogdanoff or F. Kozin, Symposium co-chairmen, Division of Engineering Science, Purdue University, Lafayette, Ind.

JANUARY

. . . **9-11**—Seventh National Symposium on Reliability and QC, Bellevue-Stratford Hotel, Philadelphia, Pa., sponsored by the IRE, AIEE, EIA, and ASQC. Contact R. L. Schwerin, vice chairman, publicity committee, Emerson Radio and Phonograph Corp., Jersey City 2, N. J.

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